JANUARY 1958

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ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

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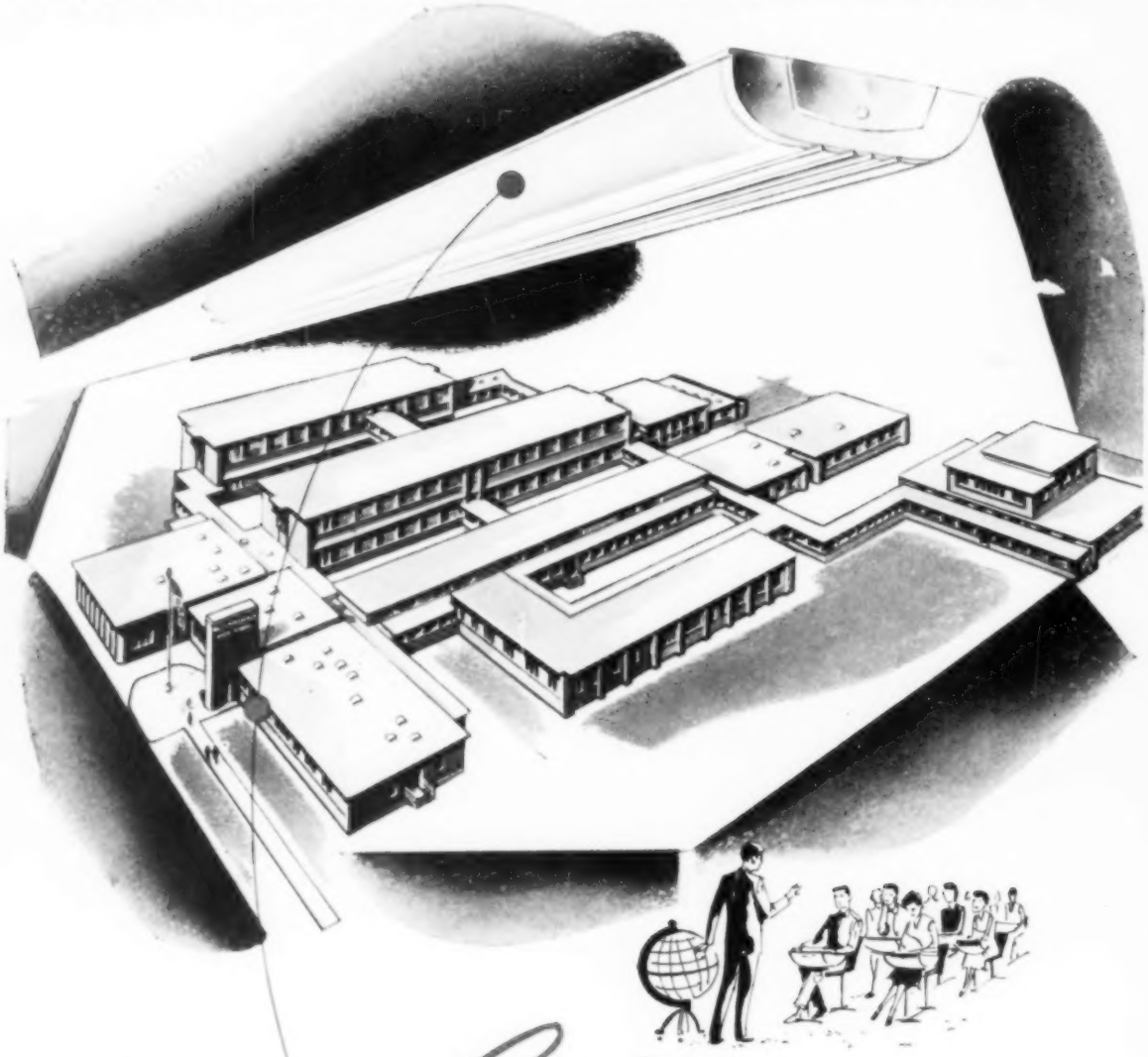

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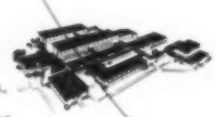

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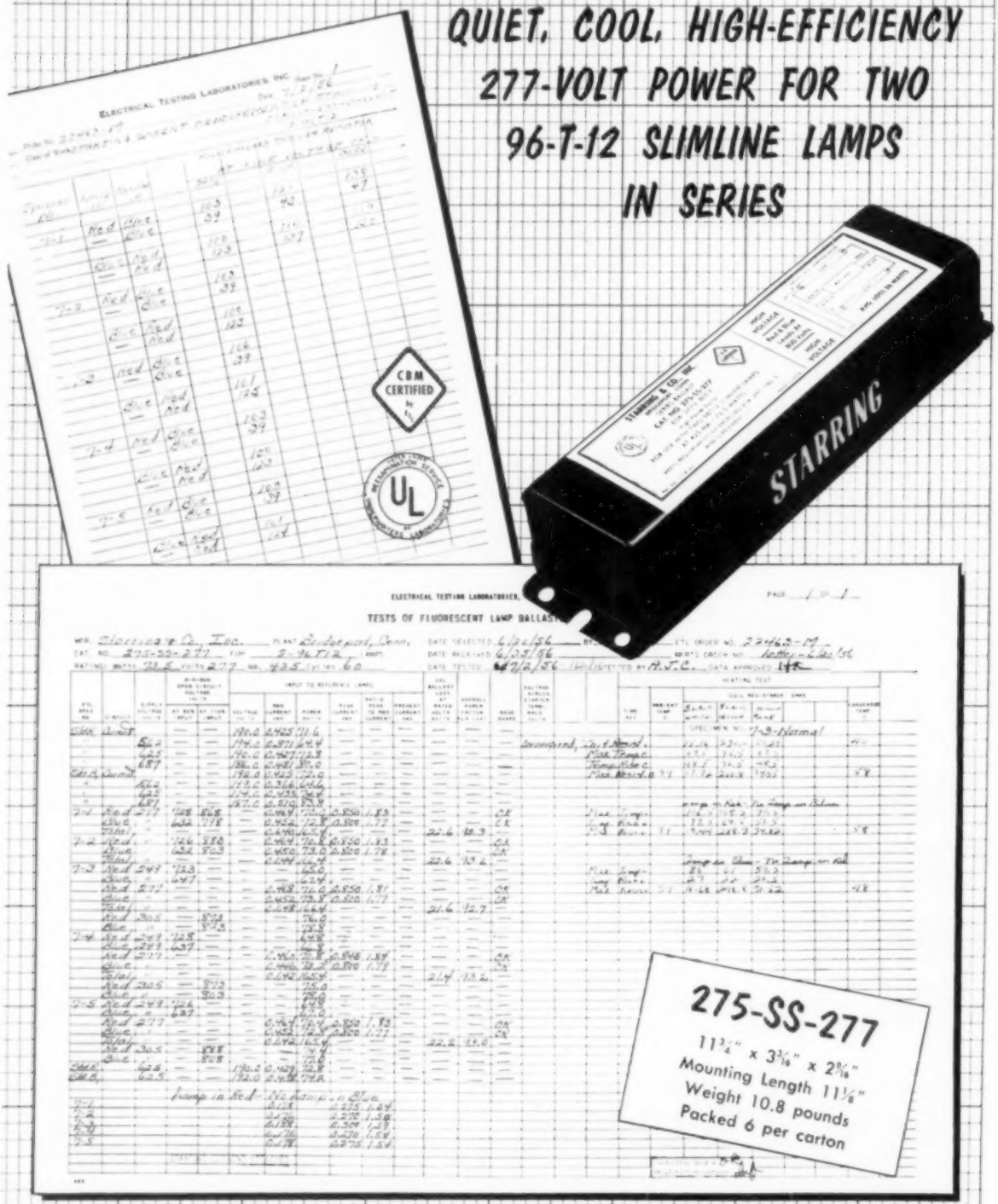

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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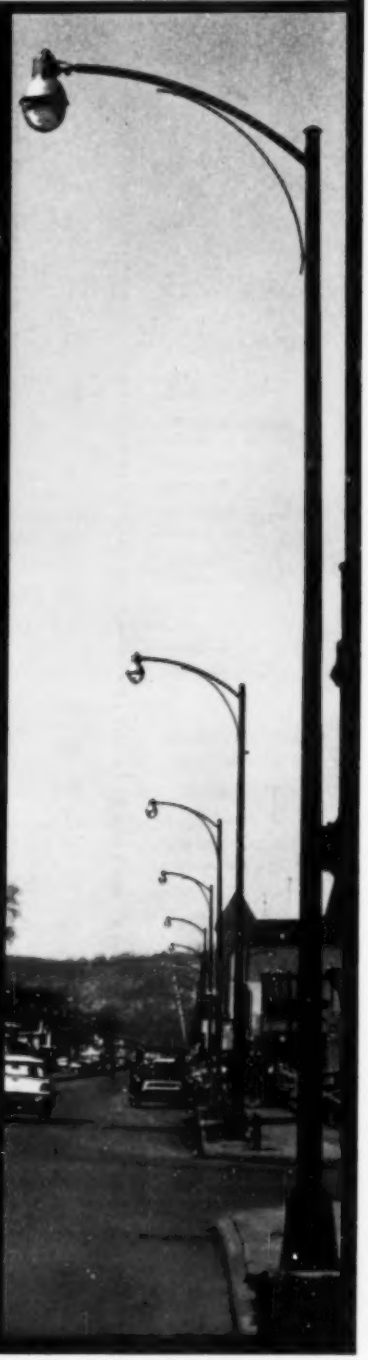
Westinghouse OV-60 | GE Type R | Pemco Mercury Oval | Line Material Spherolite Sr. | Revere Endoval



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And *proper* street lighting plays a vital role in cutting accidents and crime, providing a pleasant and safe way for those who venture out after dark.

You'll find Corning lenses at work in street lights—and in many other special forms of lighting because only *engineered glass* can do the job so well.

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Foresight is a habit with Curtis... Visioneers in planned lighting

Curtis **SKY-LUX** fluorescent luminaires bring out the natural brilliance of displays in the China department, Dayton's Southdale Regional Shopping Center, Minneapolis, Minn. Architect and Engineer: Victor Gruen & Associates.

4' x 4' Surface Mounted **SKY-LUX** With CurtiCell Louver Diffuser

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High-level illumination in modern low-ceiling design achieved with Sky-Lux Luminaires

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Visioneers in Planned Lighting®

Agree?

There's a lot of Planned Quality Lighting Here at Standard Fixture Cost!

Appearance as well as cost were important considerations in this new bank installation by Litecontrol. But the primary objective was good *functional* lighting!

Litecontrol recessed curved-lens troffers were used throughout to do two jobs: (1) Staggered over the public area they provide moderate light intensity (2) Over the tellers' counters under the balcony, they step up the intensity to the precise high level that's needed. Even the mural on the wall is adequately lighted by the row of lens troffers — no supplementary lighting is used or required. The mural is clearly visible even from the street.

If *you* have photos to show of an installation like this, you know that you not only have a satisfied customer but you make a lot of new friends. Consider LITECONTROL on your next public lighting job.

INSTALLATION:
Watertown Federal Savings & Loan Association
Watertown, Massachusetts.

AREA:
Main banking area.

ARCHITECT:
Daniel C. C. Gilbert, New York City, New York.

ASSOCIATE ARCHITECT:
Davis Hamerstrom, New York City, New York.

DESIGNERS:
Benedict-Hamerstrom, New York City, New York.

CONSULTING ENGINEERS:
Albert Fentzlaff, Inc., Gustave B. Weiser,
New York City, New York.

ELECTRICAL CONTRACTOR:
Howes Electric Company, Watertown, Mass.

FIXTURES:
Litecontrol No. 4734RS in Public Area;
No. 4724RS in rows over Tellers' Counter.

INTENSITY:
Average in Public Area, 25 footcandles in service.
Average on Tellers' Counter, 85 footcandles in service.

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

Lighting Progress in 1956-1957

Prepared by the Committee on Progress of the Illuminating Engineering Society

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The accompanying illustrations were chosen as answers to specifically — "What's new in lighting this year?" In addition to the pictures, however, attention should be called to several trends which are believed to be important this year.

The illuminating engineer is becoming more conscious of decor and of appearance, in addition to his more traditional attention to efficiency. This is demonstrated in several ways.

Luminaires are growing *larger* every year. Troffers—two, three or four feet wide—are commonly available for recessing. Suspended "rug size" luminaires are claimed to solve labor jurisdictional problems inherent to luminous ceilings, for where a 9-foot x 12-foot unit hangs free from the walls there is no question as to whether the carpenter or the electrician does the installing.

Luminaires are becoming more *shallow*. Some surface mounted units are indeed so "swept" against the ceiling that at first glance they appear to be recessed. This seems to follow a growing demand for "unobtrusive" luminaires for general lighting. At the same time recessed units are becoming thinner to avoid complications with air-conditioning ducts and with other "services" which are each year using more space between the ceiling and the floor above.

Color is becoming more common in general lighting. Interchangeable colored ceiling modules vie with colored plastic side panels and colored enamelled bodies in this year's offerings. More variation is noticed in the available improved color mercury vapor lamps. Impetus for the use of fluorescent lamps in homes is given by changing a name from "warm white deluxe" to "home line" in an attempt to show the homemaker that fluorescent lamps *can* be used happily in a home.

Texture and *form* are more varied. Interchangeable panels in hung ceilings allow freedom of imagination for designers through the use of formed panels with varying shapes, colors and finishes.

Fluorescent lamps are utilizing *higher and higher currents*. Efficiencies of a selected group of high-current luminaires run in the order of 70-80 per cent. Industrial luminaires tend toward 10-25 per cent uplight as lamp current goes higher. Ballast heating has been considered by using special air-conditioning and by producing ballasts in separate units.

Illumination levels have increased. A factory with 150 footcandles of general illumination is reported, and trial installations of 1000 footcandles are being studied.

Street lighting shows more variety than ever before. A continuous line of light down the center line of the street; high frequency; low brightness luminaires for relatively concentrated sources; and a full scale laboratory for comparison of lighting systems, are all new developments for street lighting this year.

Garden lighting gathers more fans every year. Clue to its popularity as a home lighting technique was the number of visitors to the garden lighting display featured at the Progress Report during the Atlanta Conference. This was an elaborate "replanting" of an entire garden, complete with living plants and garden lighting equipment. Initiated by the Atlanta Section Residence Lighting Forum of I.E.S., this excellent display was planned, arranged and installed by the Forum members, in cooperation with the Atlanta Garden Club. Chairman of the project was Miss Ruth Morris, chairman of the I.E.S. national committee on Residence Lighting Forums.

This year the submissions for consideration by the Progress Committee were somewhat fewer than in some years past, but a higher percentage was, in the group opinion, "new and interesting." This partial evidence of a trend toward fewer trivia and increased ingenuity bodes well for the development of the industry.

Approved by the Council of the Illuminating Engineering Society. December 12, 1957. A Transaction of the Society.

Exterior Lighting

Figure 1. Largest man-made Christmas tree, 100 ft. tall.

Figure 2 (right). The outdoor candlelight performance of the opera "Carmen" on the night of August 23, 1957, Asheville, N. C. The spectacle was promoted by the Brevard Music Institute, Brevard, N. C. The stage setting was on the 750-foot porch of the Biltmore House built between 1890 and 1895 by the late George Vanderbilt. This is an example of what can be done with the most modern fluorescent floodlighting equipment combined with French Renaissance architecture. The effect produced was that of a sparkling fairyland castle which provided the desired background and atmosphere required of such a pageant.

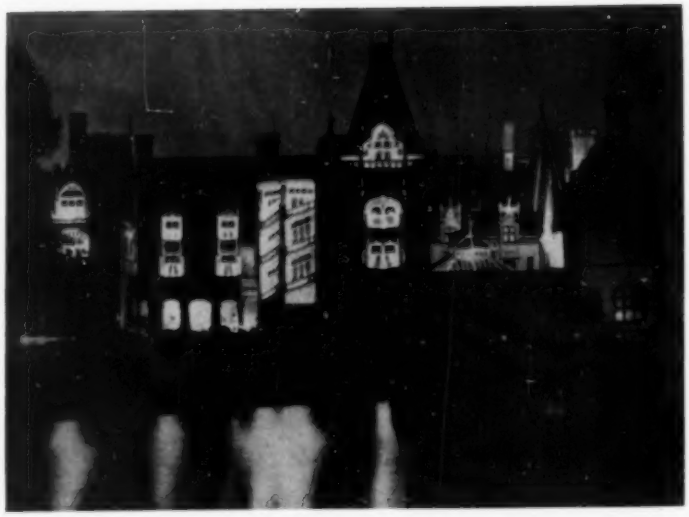


Figure 3. High-current fluorescent lamps for poster panels.

Figure 4. Transilluminated building fronts for service stations. Fluorescent lamps on 8-inch centers.

Figure 5 (right). The exterior walls of this (Old Point Comfort, Hampton Roads, Va.) lighthouse and several others are being illuminated to test out the feasibility and advantages to be gained. It is believed that floodlighting will: (a) Enable the mariner to more readily identify the aid to navigation and use his natural depth perception to judge the distance of the lighthouse. Ordinarily it is very difficult to judge the range of a source of a beam of light. As a result of this better orientation the risk of collision and damage to the lighthouse is reduced where that danger exists due to the proximity of the navigable channel. (b) Enable the mariner to take bearings on the lighthouse between flashes. (c) Make the tower more conspicuous against background lights at short ranges. (d) Decrease the tendency of migrating birds from becoming dazzled by the intense beam of the main light and fly into the lantern. (e) Enhance aesthetic appeal and public relations. As in other fields — it pays to advertise! (This photograph was obtained through the courtesy of the United States Coast Guard.)

Figure 6 (left). Twenty-three xenon filled condenser discharge beacons on the center line flash in sequence two times per second down the approach systems at March Air Force Base, Calif. They create an effect like that of giant tracer bullets fired at 3600 miles per hour toward the safe landing area. Each flash produces 30 million candlepower for a duration of 1/5000 second. The center row of flashing beacons is flanked by incandescent lamps providing an artificial horizon for roll guidance. This is the first flashing approach system used at a military base and is first at any field — military or civilian — in the western United States.

Figure 7. Columnar taxiway lights installed on a taxiway at New York International Airport.

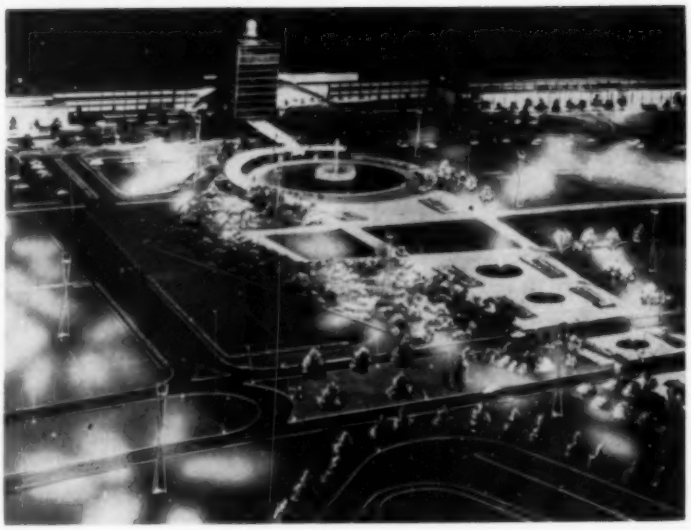


Figure 8. This is believed to be the largest single area ever to be floodlighted. The parking areas of Idlewild International Airport consist of approximately 160 acres illuminated from 338 1500-watt mercury floodlights mounted on 43 towers at approximately 72 feet above the ground. The average illumination varies from approximately eight to three footcandles.

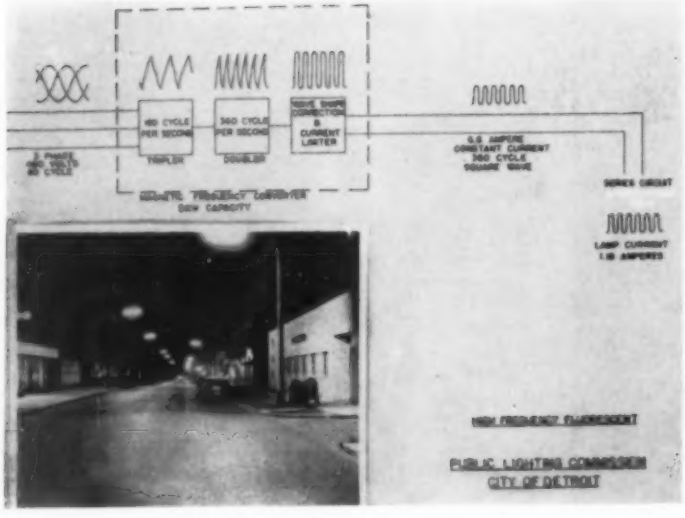


Figure 9. The first commercial high frequency outdoor fluorescent installation in the City of Detroit. A static magnetic frequency converter changes standard 480-volt, three-phase, 60-cycle sine wave power, first to 180-cycle single phase, then to 360-cycle single phase and finally to a regulated constant current of 6.6 amperes, square wave, 360 cycles under 1000 volts. 25 per cent additional light is said to be available from fluorescent units operated on square wave power at high frequencies.

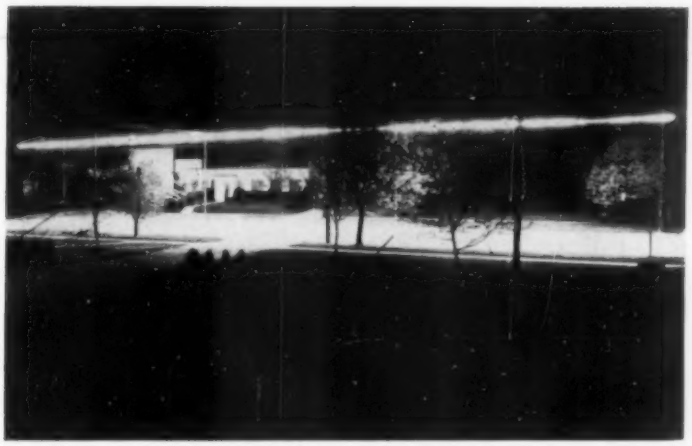


Figure 10. This shows the first commercial installation in Dayton, Ohio of fluorescent units mounted at a height of 25 feet with the lamps parallel to the curb. Here, 32 single-lamp, six-foot units are installed in a continuous line over the center of a 40-foot roadway. An initial level of approximately 15 footcandles is provided on the pavement. The uniformity of illumination in this installation is unsurpassed. The system is experimental.

Figure 11. If a picture is worth 1000 words an actual full-scale installation is worth 1000 pictures. This is the view of a newly completed demonstration street. By merely flipping a switch while standing here at these "Crossroads of Light" one can see comparative results of 6 different systems of incandescent filament, 5 mercury vapor and 8 fluorescent installations.

Figure 12. Outdoor fluorescent floodlights have been recently installed in a Southern Railroad Inspection Yard for an unusual application. The unit is mounted at ground level just inside the tracks and aimed upward at an undercarriage inspection point. This provides superior illumination levels with a minimum of shadows at much less cost per footcandle than the conventional incandescent units or portable lanterns commonly used.

Figure 13. The 30-inch General Purpose Searchlight was developed by the USAERDL, Fort Belvoir, Va. Though it has only one-quarter of the optical area of the standard 60-inch searchlight, it has a peak beam intensity of 450 million candles as compared to 600 million for the 60-inch searchlight. This is made possible by a carbon arc source whose brightness is 1500 c/mm^2. The beam is 2½ degrees wide and has a lumen output of 320,000 lumens. The arc uses 15 kw with 190 amperes through an 11 mm carbon. This searchlight can operate continuously for more than 12 hours by use of an automatic positive carbon rod feed with a circular disc negative. Indirect illumination coverage of this searchlight out to 10,000 yards is equal to or better than the 60-inch searchlight.

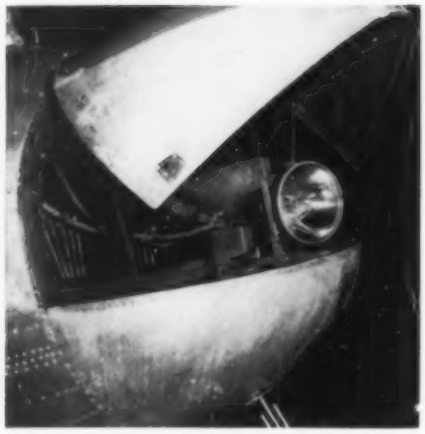


Figure 14. Continuing anti-collision research is being conducted to increase daytime conspicuity of high speed aircraft. This shows a sweep beam light installed in the nose of a DC-3 by the Civil Aeronautics Administration, Technical Development and Evaluation Center, Indianapolis, Ind. Sources such as the 600-watt landing light and a mercury vapor capable of producing a million candlepower have been flight tested. Both of these sources show promise of increasing the range at which an airplane can be detected in bright daylight. The maximum range so far confirmed is 22 miles when the plane itself was not discernible beyond 16 miles.

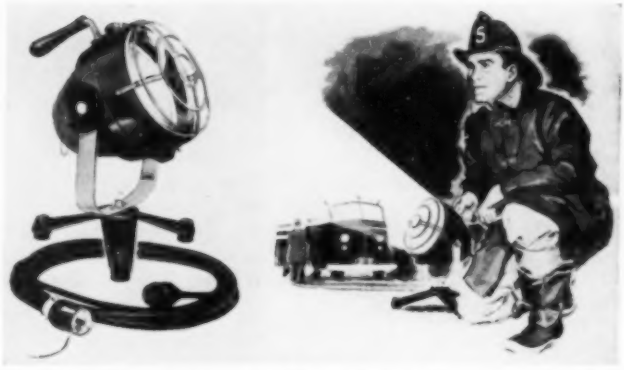


Figure 15. This is a newly available 500-watt completely portable emergency unit. It produces 121,500 candlepower and is said to be "the most powerful light-weight portable in the world." It is completely waterproof and weighs only 13 pounds.

Figure 16 (left). A king-size reflector gives relatively low brightness, even with incandescent filament or mercury vapor street lighting.

Figure 17. This newly available incandescent sign-board gasketed unit employs two 200- or 300-watt medium base lamps. It features louver type ventilation equipped with "bug" screens and weep holes to permit escape of condensed moisture. The heat and impact resistant lens is specially shaped to allow rainfall to keep the glass clean.

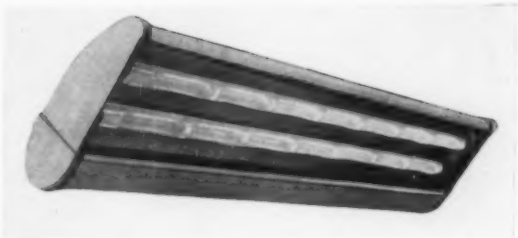


Figure 18. This new outdoor unit employs one of the highest lumen output fluorescent lamps available today. Its sleek design uses extruded aluminum and resembles an airplane wing.

Figure 19. This is a view of the newly available 1500-watt mercury floodlight specially designed to meet the requirements of the vast automobile parking areas at the Idlewild International Airport.

Figure 20. A recently available piece of prismatic glassware is specially designed for use with mercury vapor lamps. This can be used in such applications as outdoor substations where the output and long life characteristics of the merury vapor lamp are desirable while retaining the necessary light distribution and vertical surface illumination properties formerly obtainable only with the incandescent filament lamp.

Figure 21. A floodlight utilizing 400- or 1000-watt clear or improved-color mercury vapor lamps is now available. Beam spreads produced vary from 28 degrees to 114 degrees with corresponding beam efficiencies of 43 to 76 per cent.

Figure 22. This is a highly competitive business. Manufacturers are striving to provide users with the best possible designs to produce the most footcandles for the smallest investment.

Figure 23. The rugged, resilient nature of a new plastic for fluorescent luminaires is demonstrated. The four-foot long polystyrene pan easily withstands 180 degrees twist without cracking or breaking. Such strength protects the pans against damage during shipping and handling.

Figure 25. New gas mixture, new metals and cathode construction provide longer life and higher lumen maintenance in the T12 end chamber type extra-high-output fluorescent lamps.

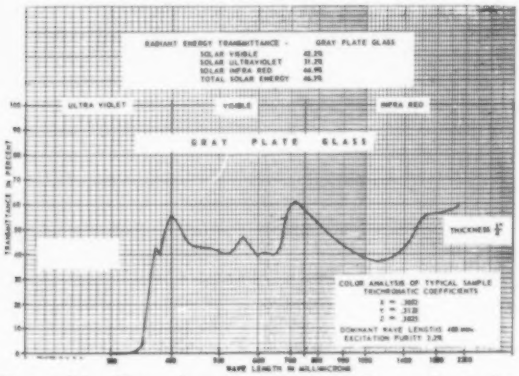


Figure 24. Plate glass can now exclude much of the heat spectrum without producing a greenish cast on the complexion.

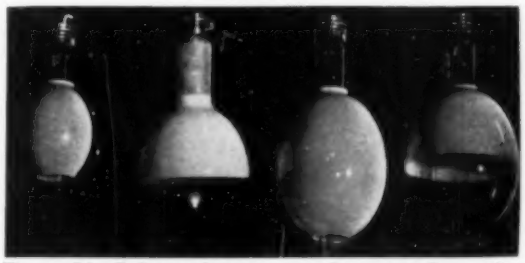


Figure 26. Deluxe white mercury lamps produce color quality light for commercial lighting made possible by pink-purple luster coating plus fluorogermanate phosphor, providing both additive and subtractive color correction.

Figure 27. New bulb shape for mercury lamp for semi-indirect lighting. This new BA 56 bulb containing a 400-watt mercury arc tube and phosphor coating on the bowl surface provides 2/3 upward light, 1/3 downward, and can be obtained in either the regular or the deluxe white color.

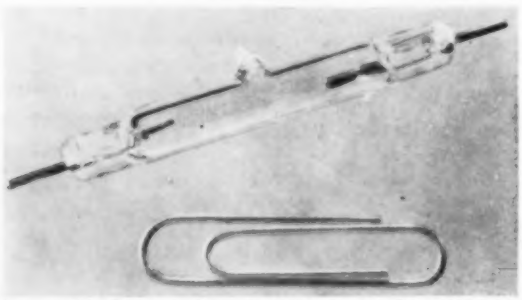


Figure 28. Lower voltage ignition timing lamp, FT 30.

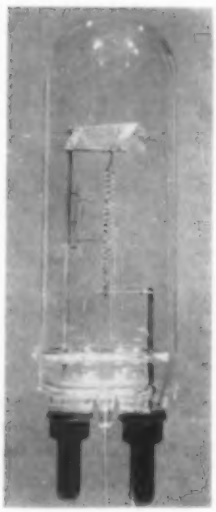


Figure 29. Airway beacon lamp for airports landing high-flying jet aircraft.

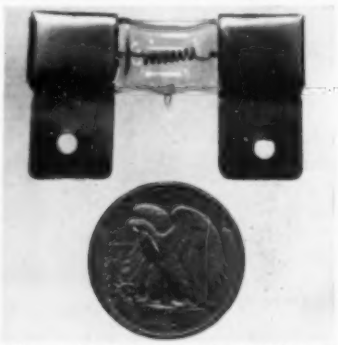


Figure 30. This 2¼-inch 150-watt quartz lamp is rugged and compact making it ideal as a wing-tip lamp.

Interior Lighting
Commercial, Industrial

Figure 31. A cove-lighted college swimming pool.

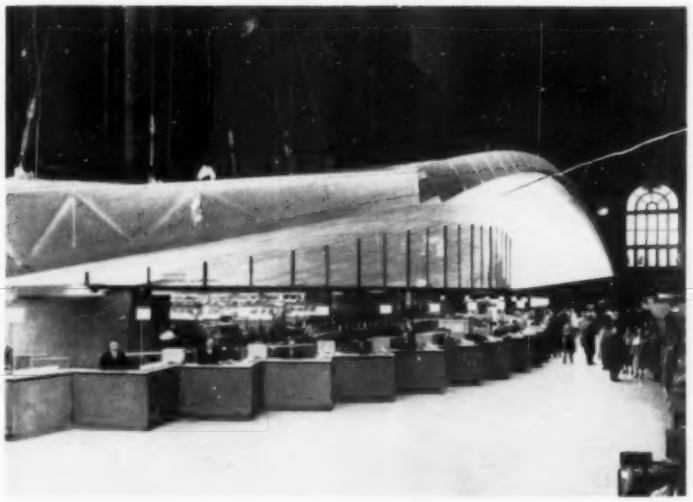


Figure 32. Pennsylvania Station in New York has this floating aluminum, steel and glass canopy of light, 164 feet long and projecting 43 feet out from the wall. Air-conditioning ducts and 3200 fluorescent lamps are installed above the aluminum louvers, composed of some 13,552,000 hexagonal cells. TV receivers at the counter bring information about space availability directly from the interior of the Service Bureau to the point of sale.

Figure 33 (left and below). Interchangeable ceiling modules allow variety in color, form and texture.

Figure 34. Thin translucent plastic sheets stretched across frames. Entire frame is then hidden by aluminum mullion.

Figure 35 (right). A floating panel luminaire in a private office.

Figure 36. This plastic ceiling does not run from wall to wall, but is a "rug size," allowing an open area between the ceiling and wall.

Figure 37. An accoustical baffle, metal louver combination for noise and brightness control in a classroom.

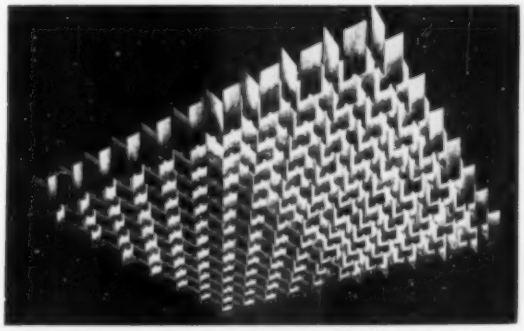


Figure 38. Alternate leaves of this louvered ceiling equipment rotate 90 degrees so that all lie flat for easy cleaning without special equipment. Because of this unique design, separate leaves may be colored in unlimited variety, providing unlimited design possibilities. Even the two sides of one leaf may be of different colors.

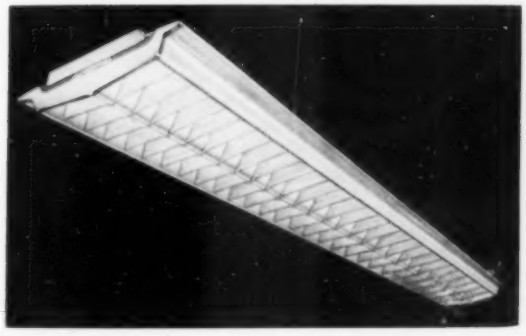
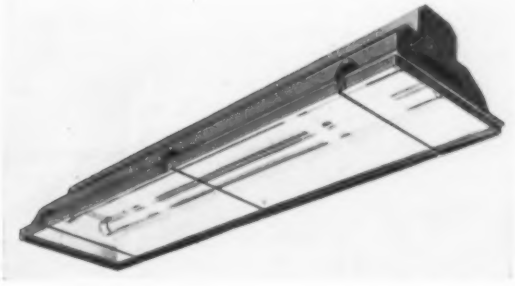


Figure 41. A luminaire designed for low ceiling mounting in areas where visual comfort is important. Low side brightness is achieved by double wall construction providing graduation of tone blending into the surrounding ceiling area. Low end brightness is obtained by the use of louvers consisting of a series of sections of a parabola.



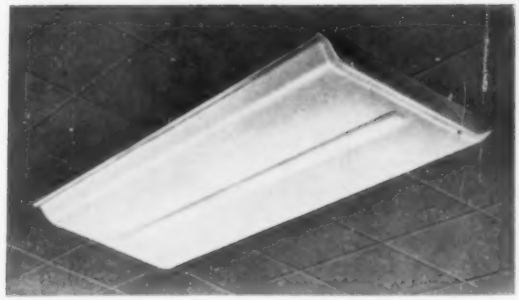


Figure 39. A very shallow plastic enclosed unit. The plastic enclosure forms the sides and portion of the ends. The end return of the diffuser provides a smooth visual transition from one luminaire to another within a continuous row.

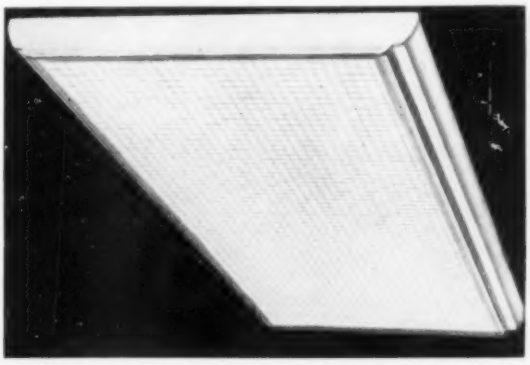


Figure 40. A series of parabolic shaped reflectors provides an even distribution of light over the entire diffusing area of this luminaire. Shallowness is achieved by hiding the ballast in the sides of the unit, rather than in the middle.

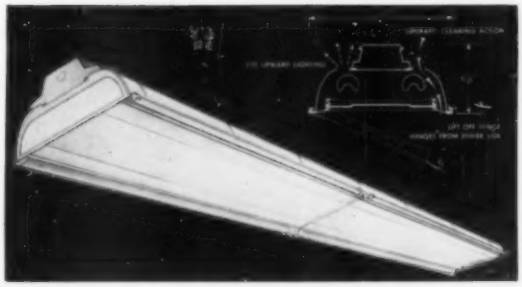


Figure 42. A luminaire for harnessing the output of high-current lamps. This industrial unit is designed for visual comfort in high or low bay installations. Brightness is controlled lengthwise as well as crosswise by the plastic diffuser. The reflector permits a 23 per cent upward component of light.

Figure 43 (left). Porcelain enamel, stainless steel, and Monel metal are supplied in a corrosion-resistant industrial luminaire listed as Class II F and II G.

Figure 44. A luminous cone luminaire designed for high wattage reflector lamps for use in a high mounting area.

Figure 45. A high bay fluorescent installation at an iron works. Fifty footcandles from 30 feet above.

Figure 46. High level (150 footcandles) general illumination with high-current lamps eliminates the need for supplementary lighting in a machine shop.

Figure 47. This unusual garage installation combines the economy of an unshielded luminaire with protection against lamp breakage from automobile antennas.

Figure 48 (right). Designed for use with any standard transparent type liquid level gauge, this explosion-proof gauge light gives even illumination over the entire length of the gauge. The light source is a 25S P8DC lamp.

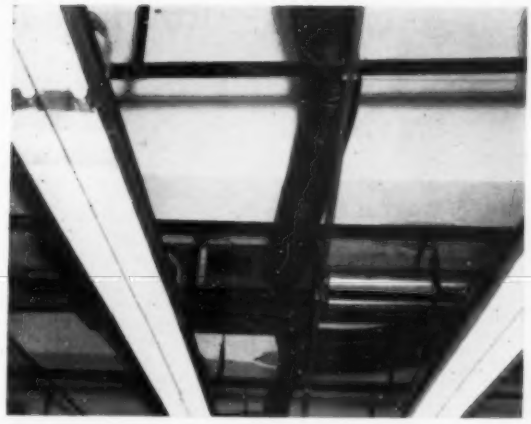


Figure 49. Shown here is a system of bleeding cold air into the ceiling plenum for maintaining the proper operating temperatures for the fluorescent lighting system. This prevents overheating of the ambient air in the troffers and results in higher light output.

Figure 50. Industrial lighting installation of 1000 footcandles, reported comfortable, uses high-current lamps in aluminum reflectors.

Figure 51. High temperature, for fusing materials, is obtained by using quartz T-3 lamps.

Figure 52. Designed to provide supplementary illumination, these luminaires are in operation in a mine many hundreds of feet under the earth's surface. They provide a safe system for illuminating underground working areas.

Figure 53. Sparkling luminous ceiling adds spaciousness and hospitality to apartment hallway.

Figure 54. Colored lamps, behind packaged luminous ceiling element, bring sunshine qualities to modernized kitchen.

Figure 55. Decorative wall element in dining area is made from wood shavings impregnated into sheet plastic to form design pattern. The element is lighted with incandescent reflector lamps.

Figure 56. Happily revealing toiletry is dividend from combination of luminous ceiling and mirror side brackets. The "rug size" ceiling unit is equally suited to the private office.

Figure 57. Lighting for unity with house design, continuity of effect and adaptability to living patterns comes true only with complete collaboration of family and all designers.

Figure 58. The use of 25-watt, 30-volt incandescent filament lamps in a series with an appropriate switch control to give various levels of lighting from a luminous ceiling system. Part of installation is on dimmer control.

Figure 59. Luminous ceiling as applied to the home. (Phone number not available.)

Figure 60. Same effect as Fig. 59, except for the lighting. (Here the *walls* are transilluminated.)

Figure 61. Dining room lighting with 12 recessed downlights using pink, blue-white and gold reflector lamps, four of each. Each color can be individually demonstrated or used together for a variety of lighting tints. The light gray carpeting and walls support the action of the cool mixture.

Figure 62 (left). Glamorous vanity mirror using G-16½ lamps and perforated metal reflectors, painted in flesh tint.

Figure 63. Lighting sets the pace for variable living needs in a renovated attic.

Figure 64. Wall lamp of knock-down design for lighting projects for adult and youth groups, schools, 4-H groups.

Figure 65. A lighting engineer's solution to his own recreation room lighting problem.

Figure 66. Circular steel dome luminaire, 30 inches in diameter, is a direct-indirect unit using a 200-watt incandescent lamp and a Fresnel type lens.

Figure 67 (right). Night light that lets you dial the amount of light you want . . . provides soft illumination that is fully controllable from "dim" to "bright." Shown here is the operation of the simple shutter control, which regulates the exposure of the 3000-hour 7-watt lamp. The new night light is also equipped with an on-off switch. Plugs directly into wall outlet.

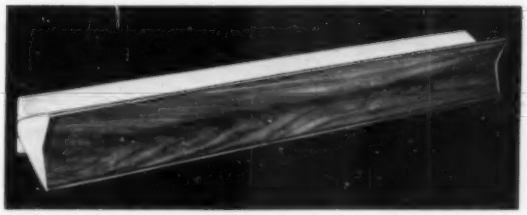


Figure 68. Wood-faced wall valance furnishes up and down light.

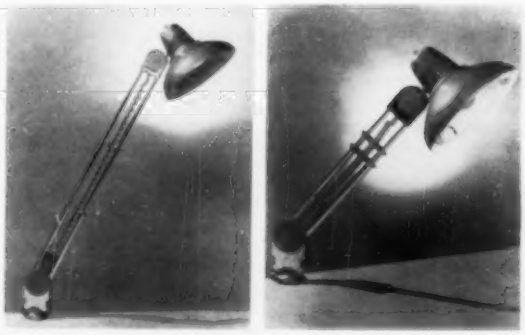


Figure 69. This luminaire has a telescoping tube and an expandable cord. Using a principle similar to that of a slide trombone, it can be expanded or retracted as desired. The unit can be rotated at both base and shade and thus the light can be positioned for the working area.

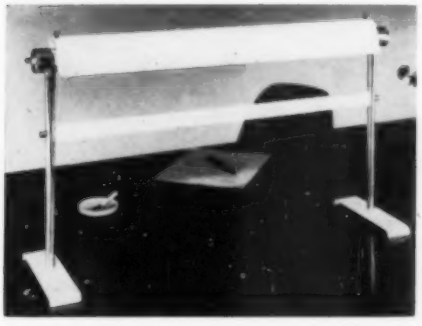


Figure 70 (left). Fluorescent desk lamps have a new appearance.

Figure 71. Incandescent study lamp diffuser made from one-piece vacuum formed plastic shaped as one piece to make 11-inch diameter diffusing bowl and shade; uses 50/100/150-watt lamp.

Figure 72. Wall-mounted fluorescent desk light with polished brass support arm.

Figure 73 (right). Fluorescent floor lamps, too, have produced new styles.

Garden Lighting

Figure 74 (below) Atrium inside the house separated from living room by glass but open to the sky. Three separate controlled lighting effects—first, consists of six blue-white reflector lamps and one pink reflector lamp. These downlights create cool pools on the black slate floor, and their color enlivens all of the colors in the plants and the flower colors. Second system consists of concealed back lighting below the low plants, lighting along two sides. Third effect is produced by back lighting the translucent dividing screen on the left.

Figure 75 (right). Umbrella-shaped luminaire for path, garden and shrubbery lighting.

Figure 76. Translucent garden border light, portable for plug-in.

Lighting Abroad

Figure 77. Floodlighting of L'Hotel de Ville, Paris, France. Illuminated by 12 projectors.

Figure 78. Floodlighting of Le Pont Neuf is provided by ten 1009-watt projectors with horizontal spread lenses.

Figure 79. Illumination of Champs Elysees, Paris, France. The old gas lighting on the Champs Elysees has been declared a national monument and cannot be removed. To obtain better illumination, fluorescent mercury luminaires on high poles have been added. The mercury lamps are 400-watt golden white, mounted at approximately 25 feet. The poles are spaced approximately 75 feet apart.

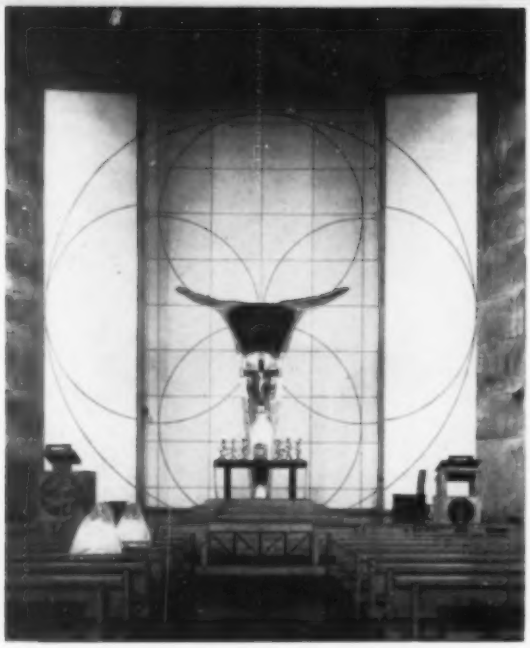


Figure 80. St. Anselm's Meguro Catholic Church, Tokyo. White wall surface behind crucifix is washed with light from nine 100-watt incandescent lamps on each side. Spotlights with 100-watt incandescent lamps are used to illuminate modernistic crucifix and vertical panels on either side of altar.

Figure 81. Japanese living room, Mr. Eiichi Ikeda's residence, Tokyo. This room is 80 square feet. Ceiling: recessed luminaire with spun-glass bottom, four 20-watt white fluorescent lamps plus two 40-watt incandescent tube lamps. Alcove: one 10-watt white fluorescent lamp. Stand: 60-watt incandescent lamp.

Figure 82. Tennis court at Romainville. Illumination is from four-lamp 40-watt fluorescent luminaires arranged overhead along the side lines of the court. Thirteen luminaires on each side are mounted about 30 feet from the floor and provide approximately 35 footcandles.

Figure 83 (right). Xenon color testing unit. In Germany the daylight quality of light produced by a discharge through xenon gas is used for precise color matching. The xenon spectrum is unchanging and completely reproducible so it is being offered for consideration as a basic standard.

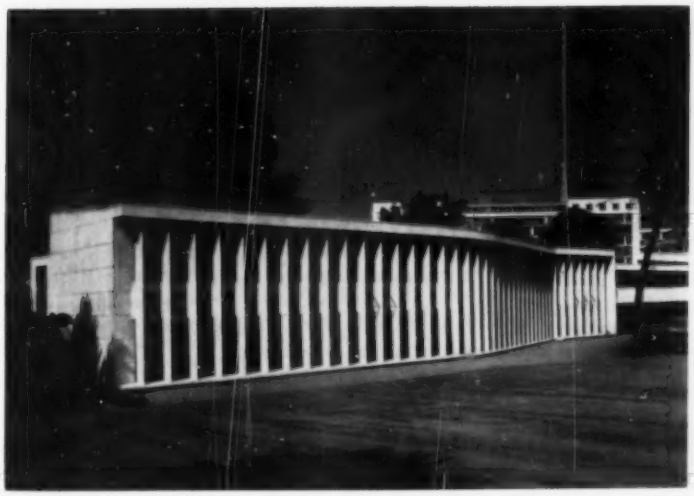


Figure 84. Controlled daylighting, school at Paddington, England. The large structural panels of light concrete form effective louvers reducing glare from slanting rays of the sun. These elements also provide an interesting appearance to the building and structural strength.

Figure 85. Japanese Memorial print commemorating first electric street lights in Japan. This shows the artist's conception of the brush arc light installed in 1887 on the Ginza which is the main street of Tokyo. The Japanese have recently installed an operating replica of the original arc light. They have mounted a reproduction of the old time lantern on a high wooden pole with a modern 1000-watt quartz mercury lamp as the light source.

For 1957 Indexes—Watch for February I.E.

Subject and Personnel Indexes for 1957, traditionally Section II of January ILLUMINATING ENGINEERING, will this year be a supplement of the February issue.

The Personnel Index will constitute a Roster, with business addresses, of all Committee appointees and national and local officers of I.E.S.

Optical Applications of Mercury Short-Arc Lamps

By E. W. BEGGS

The arc of a mercury short-arc lamp is a "ball of light" which is about ten times as bright as a tungsten filament and which approaches the intrinsic brightness of a high intensity carbon arc. The color and brilliance are quite uniform but greatest brightness occurs in the vertical core and bright white spots develop at each electrode surface. The light has the blue-green-white color of the mercury spectrum but is whiter than mercury lamps for general lighting service due to the high operating vapor pressure developed. Powerful ultraviolet energy bands are available and are sometimes applied. The 5461-A line can be segregated where monochromatic light is needed. Short-arc mercury lamps are used in searchlights, instruments, and image projectors. They are also used in photochemistry and photoprinting, where their concentrated actinic rays increase speed and their spectral quality favors accuracy of reproduction.

THE GRADUAL development and perfection of short-arc mercury lamps has been reported to the Society during the last few years. Today the prediction of the past with respect to the potential usefulness of short-arc mercury lamps in general has been realized. They are being used in all of the applications anticipated and in addition, in others that were not considered likely to develop.

These lamps are made in two types — one, the mercury lamp, with a small amount of argon as an ionizing or starting gas, and the other known as the mercury-xenon lamp, designed with a pressure of several atmospheres of xenon gas to provide intense illumination within a few seconds after the arc has struck. After the lamp heats up and the mercury is all vaporized the characteristics of the two types are quite similar.

The various applications of short-arc lamps are all made possible because these lamps develop an intensely bright, small and almost spherical source of light. They in effect approach the "point source" illuminant that is so vital to most optical applications. Their use, therefore, in general consists of varied applications where the light used must all come from one relatively small area or spot.

In illuminating engineering, a "point source" is needed chiefly for searchlights, for picture projection and for optical instruments. In the past, where high power was needed, the carbon arc was always used. Where lower brightness sources could be used, incandescent lamps have been applied.

The short-arc lamp is a bulb type light source with characteristics similar to an incandescent lamp, but with brightness, and light source shape and size comparable to that of the carbon arc. In high wattages, therefore, the short-arc mercury lamp is being introduced for use where the carbon arc was formerly required. Such an application is the high powered searchlight used for military, marine and recently for advertising purposes. Today the most important application of short-arc lamps is the use of the 1000-watt mercury-xenon lamp in 12-inch U. S. Navy searchlights.

Another important field for short-arc lamps is instrumentation. The familiar comparator used to project magnified silhouette images of machine parts requires highly controlled light flux both in intensity and angle. Comparators up to recent months had depended entirely upon small brilliant incandescent tungsten filament light sources. Recently, however, where high power is needed, advantage is being taken of the unique qualities of the short-arc lamp. In this way the brilliance of the image is increased many times and the sharpness of the shadow reaches a degree of perfection not hitherto possible with other sources.

Projection of pictures or images on a screen is an important use of mercury short-arc lamps. The color of the light is blue-green white, however, so this field will be limited until the pure white light of the xenon short-arc lamp is available.

Between the two extremes of the high-powered

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHOR: Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

searchlight and the small brilliant light source for instruments lie many "point source" applications that have scarcely been considered heretofore. One of these, for example, is photographic projection printing. Another is the etching of sharply defined images and patterns on photosensitive glass. Another is printing enlarged images of microfilm file records on diazo print paper. Another is the new and rapidly expanding field of polarized light in which controlled beams of radiation are required. Still others are the projection of images for television stage backgrounds and the quick magnification and study of a television tube image by large groups of people as in the SAGE inter-continental air defense program, etc.

Each of these uses has its own specialized optical system. The short-arc light source has been found adaptable to each and generally without necessitating any basic changes in the optical elements used.

Searchlight Optics

The application of a short-arc mercury or a mercury-xenon lamp to a searchlight has involved the conversion of an existing incandescent or carbon arc unit but ultimately new units will be designed for them. The U. S. Navy in 1955 rebuilt 500 of their 12-inch signalling and navigation searchlights, substituting the 1000-watt short arc mercury-xenon lamp for the 1000-watt incandescent tungsten filament lamp formerly used. This increased the maximum beam candlepower from 100,000 to 3,000,000 and resulted in a reduction in beam divergence from 10 degrees to 3 degrees horizontal by 2¾ degrees vertical. As a result, the 12-inch searchlight is being used more extensively than before because it can be used satisfactorily for navigation and signalling work at greater distances and provides suitable signals in the daytime as well as at night.

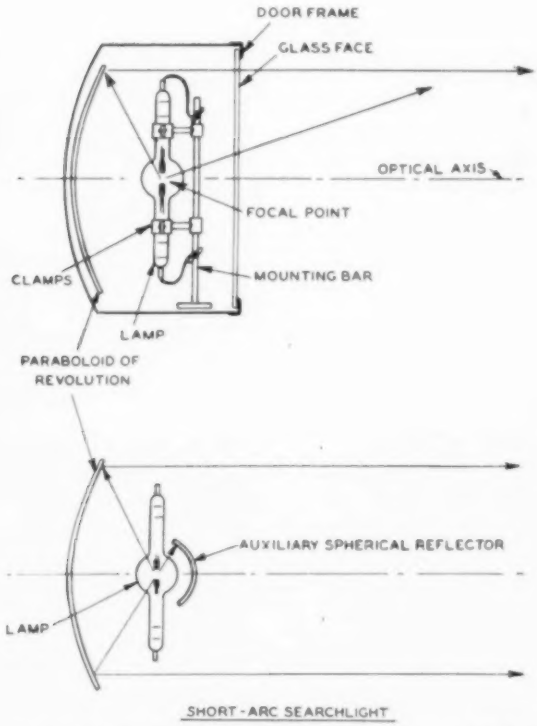


Figure 1. Short-arc lamps are now used in searchlights with axis of arc at right angles to plane of reflector. Auxiliary spherical reflector increases beam candlepower but shortens useful lamp life somewhat.

The mercury-xenon lamp was selected for this application because the initial discharge through xenon provides considerable brilliance; in fact within a matter of 5 seconds, these lamps can be brought up to 20 per cent of full brightness. The warm up time depends on the power in the pulse discharge, the circuit used, and the optical system.

In the Navy unit a dark coating of platinum metal is placed on the side of the quartz bulb away from the searchlight mirror to accelerate warm up. The coating of platinum prevents the use of an auxiliary spherical mirror and wastes part of the light that might be utilized. However, in this military application this was found desirable, in order to provide high candlepower quickly. It also reduces the hazard of overheating the bulb due to an out-of-focus front mirror and/or continued operation of the lamp in the horizontal position.

In civilian searchlight work the requirements are similar to Navy use except that a greater emphasis is placed on navigation purposes. Most civilian searchlights today are used in inland water applications. Here the light must be of higher power than for most Navy uses and there will be less dependence on radar. In addition they are almost never used for signalling nor directed up or down, which in Navy applications are common practice.

There are more boats on the inland water-ways today than ever before in history. These now generally use carbon arcs with special d-c generators provided on the barges. Short-arc mercury searchlights are operating experimentally on barges and shortly will be seen in quantity in that service. A typical application consists of two 18-inch or 19-inch units on the front end of the lead barge.

Advertising Searchlights

The use of powerful light beams in the sky to attract attention for commercial purposes has been

increasing for some years. Moving fingers of light have now become standard practice for dedicating ceremonies, important openings such as for new shopping centers, new theatres and the like. Most recently the use of powerful searchlights mounted on the tops of tall buildings has resulted in a considerable amount of interest all over the country. The reason is that for a relatively small expenditure a dignified but extremely effective way to publicize the building and attract people to it is created.

Landmark Beacons

In Dallas, Texas, the Republic National Bank chose to install a 60-inch searchlight with a 2500-watt short-arc lamp on a 150-foot tower erected above the roof of their 36-story building. This device has been running continuously each night as a rotating beacon and has served to mark the location of the City of Dallas to air and land transportation for many miles around. Reports have been received that this beacon has been seen from aircraft as far as 300 miles.

The Empire State Building in New York is perhaps the worlds most famous structure. This building was originally equipped with a tower designed for a mooring mast and embarkation and debarkation tube for passengers and freight carried by lighter-than-air craft such as the ill-fated dirigible, The Von Hindenburg, and others. Subsequently this tower was used for radio and television aerials and is now the location of the most powerful broadcasting elements of this kind anywhere. In 1955 the concept of night illumination to add eye appeal to the Empire State Building after dark and airway beacon lights brought about the installation of searchlights on the tower.

There are now four 60-inch searchlights, each equipped with a 2500-watt short-arc mercury lamp. These provide four narrow high intensity pencils of light of 450,000,000 candlepower which are swung horizontally and then up into the sky in a sort of "ballet of light." They now make the Empire State Building visible from hundreds of miles away and attract the eyes to the building and of course, serve a useful purpose to air traffic.

The optical requirements are primarily that the light source be placed at the focal point of the reflector and that each lamp be replaced before it gets too dim. The focal point has been established for each projector and the mounting bracket is adjusted to hold the lamp with the light source at exact focus. The mounting collars on the lamps are placed with a controlled accuracy within plus or minus $\frac{1}{16}$ inch. The majority of the lamps are of

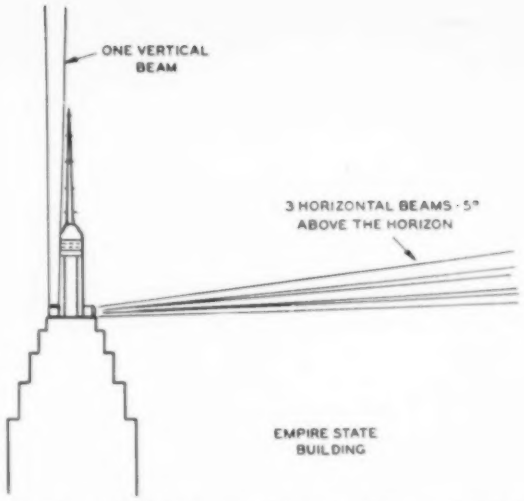


Figure 2A. World-famous Empire State searchlight beacons use 2500-watt mercury short-arc lamps, operating unattended. Lamps are replaced when brightness drops too low maintaining high-level performance, eliminating unnecessary outage.

course within less than half of this tolerance. In a fixture of this size the individual lamp variation has not been large enough to require readjustment after the lamp has ben installed in the pre-set clamping system used.

Since these lamps are burned horizontally part of the time, a secondary mirror is not used as this might overheat the bulb when the searchlights are aimed straight up. This effect is small with a new lamp but becomes increasingly important as the quartz sphere darkens. A photocell photometer is used to measure relative lamp brightness of a lamp during operation. The readings are made through a sight-hole in the side of the searchlight drum. Lamps are removed when the reading drops below

Figure 2B. Empire State beacon, with George Washington Bridge in foreground.

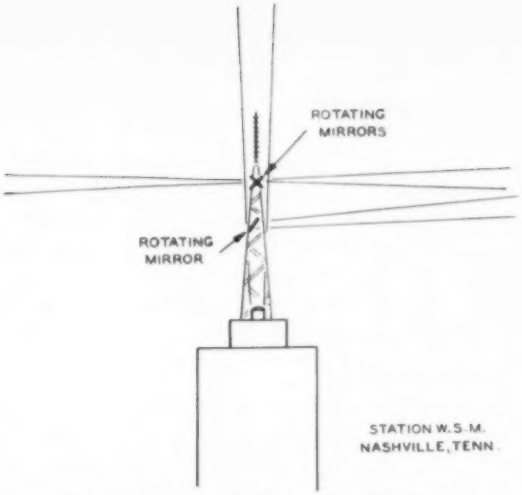


Figure 3. Vertical searchlight shaft provides multiple horizontal beacon beams from TV antenna tower. Rotating 45-degree mirrors provide scintillating effect and beam movement as aircraft warning light.

a safe and practical level, which prevents failures in service.

The newest installation of this sort is located in Nashville, Tennessee. There the searchlight is mounted on the roof of the building and the beam is directed straight up through the center of the antenna tower structure. Part of the beam flux will strike mirror elements half way up the tower. Another part will strike mirrors at the top of the tower and the remainder will go directly into the sky.

Each mirror will oscillate, developing a continuous pattern of light and movement in the sky. By having the light on the roof of the building, it will be readily accessible for servicing. At the same time the optical effect will be equivalent to that which would be obtained with searchlights mounted up the tower.

At LaGuardia Airport a shaft of light aimed at 30 degrees up into the sky acts as a guide light to pilots leaving the field, particularly in the easterly direction. Planes taking off from runway 13 aim toward the searchlight and then make their turn after they pass through or near the beam up in the sky. This reduces the noise nuisance over the heavily populated residential area of Flushing near the airport.

The longest useful life will be obtained with short-arc lamps operated in a vertical position, and the tilted position used at LaGuardia was expected to cut the useful life of the lamps used there. Nevertheless this degree of angularity has proved to be quite practical and almost full normal life will

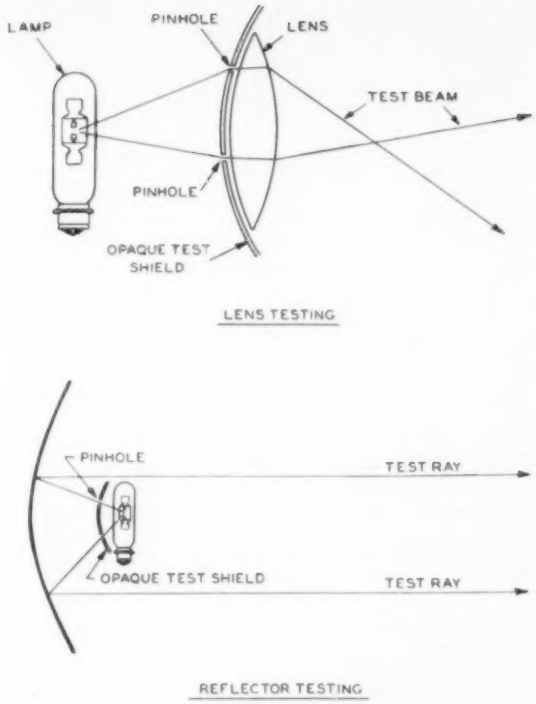


Figure 4. Brilliant pencils of parallel light from a short-arc lamp through a pin-hole aperture facilitate testing of lenses, reflectors and other optical elements.

be obtained with properly operated lamps when mounted in that position.

Instruments

In the study of lenses, reflectors, prisms, mirrors and other optical elements, controlled pencils of light are required. A so-called point source of light is essential and, in the past, small bright tungsten filament lamps have been standard equipment. With the advent of the short-arc lamp, however, this type of work will be made simpler and more accurate because of the higher brightnesses that are obtained.

Similarly, all associated optical applications such as colorimeters, polariscopes, comparators, polarimeters, microscope projectors, etc., are turning to the new higher intensity point source short-arc lamps to improve their performance.

Optical Design

In checking the aberration, both spherical and chromatic, the small source 250-watt short-arc lamp is generally used. The procedure is quite simple and consists essentially of masking all of the lens elements except a pin-hole spot located at the point to be tested. The light source and lens are placed

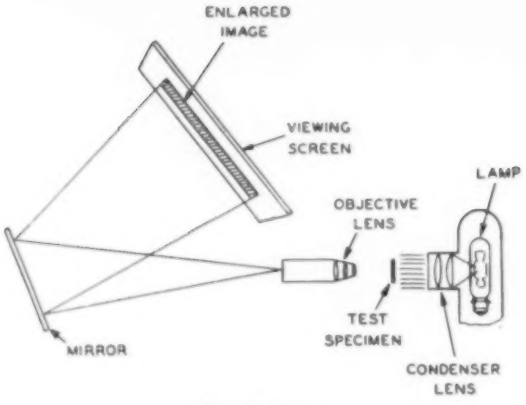


Figure 5A. Precision machine parts require precise measurement. The optical comparator provides instant information essential to the tool and die makers art. The short-arc lamp is revolutionizing the comparator, permitting it to be used in an open lighted room for higher magnification than was heretofore practical.

in accurate position, the pin-hole aperture is moved from point to point over the surface of the lens, and the path of the pencil of light through the lens, or lens system, to its target is traced. The powerful mercury lines in the blue and yellow-green zones are used to determine chromatic error by interposing blue and orange-yellow filters.

Similarly, the grinding and polishing of a searchlight-reflector, the accuracy of the surfaces of a prism, the precision throughout its acceptance angle of a colorimeter, polarimeter or other device can be checked. The high brightness and small size of the short-arc source make every operation simpler and more accurate.

Comparators

One of the best examples of new precision and effectiveness made possible by use of the short-arc lamp in optical instruments is the improved result obtained in the tool and die maker's comparator. This device creates a precise magnified silhouette image used to check the dimensions of a machine part, such as screw threads, a slot, a cam, or other shape as it is being made by the toolmaker.

Brightness of background and sharpness of shadow determine the effectiveness of this device. Also since most applications of the comparator involve a machine part that has thickness, the edge of the shadow is only as sharp and as accurate as the degree of parallelism of the light rays permits. The angle of divergence of the light rays in a good comparator is reduced by apertures in the optical system. This, however, also greatly reduces the brightness of the "picture" and, therefore, the brighter and smaller the light source, the clearer and more accurate the image will be. Short-arc lamps, therefore, are destined to revolutionize comparator work and will extend their usefulness in tool making and other related fields.

Short-arc lamps are also used in surface inspection instruments. The high intensity and spectral quality of the short-arc source is used to project a clear, accurate image of a surface on a screen. The image can then be inspected for imperfections. Such parts as master dies, matrices, etc., can be checked for absolute accuracy.

Polarizing Instruments

There are many types of polarizing devices now in use to provide information. In all of these it is important that the light rays be collimated. Of course, the light source should be as small as possible and as brilliant as can be obtained. For large work the carbon arc has been used but for most applications a small bright tungsten filament has been applied.

The new short-arc lamp has a light source brightness similar to that of a carbon-arc, being in the order of 200 to 400 candles per square millimeter. A small laboratory carbon-arc has a brightness of approximately 150 candles per square millimeter, while that of a searchlight arc runs about 650. The short-arc lamp, having a simplicity of operation like that of a tungsten filament lamp, is now being used to supplant the older type sources.

The optical system in the polariscope is quite complex. It consists of the light source itself and a condenser lens or collimating lens system designed and set to create an image of the light source at infinity. The beam is then passed through a polarizing element and the material or object to be

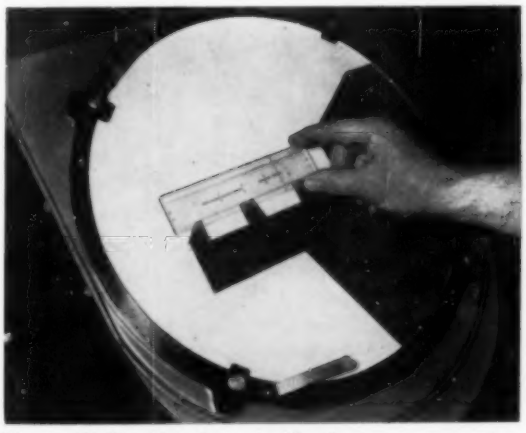


Figure 5B. Checking for magnification on a comparator.

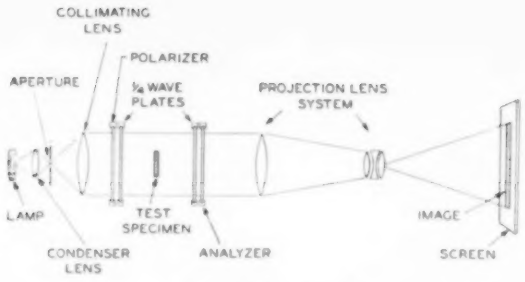


Figure 6A. Polariscopes, polarimeters and stress analyzers now provide quicker and more accurate readings with short-arc lamps. Higher intensity in the light source permits smaller aperture opening which reduces beam divergence. Mercury spectrum is easily converted by use of a filter to monochromatic light at 5460A for sharpest possible detail.

inspected or tested is placed in the essentially parallel rays of polarized light.

Polariscopes are commonly used to test the characteristics of sugar solutions and other birefringent liquids. Since the degree and direction of rotation of the polarized light is measured after the light beam passes through a column of liquid of considerable length, it is obvious that parallelism in the rays is essential. Also, of course, maximum intensity is needed since many liquids tested today are not perfectly clear. The short-arc lamp with its high brightness will extend the usefulness of existing polariscopes since it will provide accurate measurement through liquids which today cannot be measured.

Ultraviolet Instrumentation

Some of the more important applications of short-arc lamps to instruments require that the light source be a powerful generator of ultraviolet rays. The mercury and mercury-xenon short-arc lamps produce enormous amounts of ultraviolet ranging from the visible down to 2000A. The arc tubes are of quartz which transmits all radiation at high efficiency, and therefore these are ideal sources where ultraviolet is needed.

Figure 6B. Taking a reading of a polarimeter.

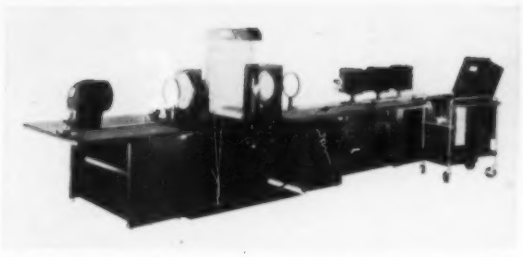


Figure 6C. A photo-elastic polariscope for stress analysis.

The spectrum of the short-arc lamp contains a series of spectral lines, the most powerful of which lies at 3650A. For fluorescent effects this is generally the most effective, and is available from either single or double bulb lamps.

The resonance line at 2537A is entirely absorbed by the mercury vapor surrounding the arc inside the quartz arc tube or bulb. However, large amounts of energy are present in side bands in the neighborhood of 2400A and 2600A and these may be used if needed. For example, some materials fluoresce only under 3650A and do not fluoresce under rays below 2600A. Others, on the contrary, fluoresce brilliantly from 2400A to 2700A and are practically dark under 3650A energy. The single bulb mercury short-arc lamps can be used for either group.

Image Projectors

Where a picture is to be projected on a screen or other surface, the short-arc lamp is appropriate as long as true color reproduction is not required. For black and white television back screen projection, therefore, a mercury or mercury-xenon short-arc lamp is well suited and the lamps are now used in that application.

Similarly in microfilm "reading," the black and white image is not only brilliant but has a clear soft blue-green color that is effective in microfilm filing operations. In the field of picture projection, therefore, the short-arc lamps are destined to find appreciable use. However, the trend to color is so strong that this field will eventually be dominated by the short-arc lamp with a discharge through straight xenon gas which develops an almost perfect daylight spectrum. These lamps are now in the developmental stage and will be made available for general use in the near future.

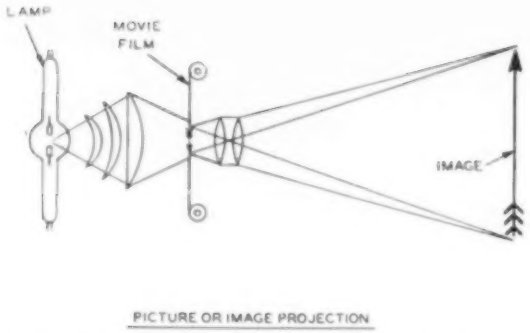


Figure 7. Where the picture need not contain all spectral colors the mercury short-arc lamp is recommended. Such applications provide superior clarity of image with eye-resting blue-green background. Conventional optical elements are found to be effective.

In back screen projection for television operation today the 2500-watt lamp is used, and the mercury-xenon type is applied in order to obtain quick warm up in case it is needed on short notice. In order to provide the maximum possible picture brightness the condenser lenses are very large, being in the order of 8 inches in diameter, and the lantern slide is oversize. Today these run as large as 5 inches x 7 inches. Also for maximum picture brightness, the light rays are thrown from the front against a high efficiency beaded picture screen. The light is projected from above the heads of the actors to avoid shadows on the screen.

SAGE Motion Picture Projector

A highly specialized and very important application of mercury or mercury-xenon short-arc lamps is in conjunction with the SAGE inter-continental air defense system. This multi-billion dollar operation involves the use of radar receiving stations located at strategic points throughout the world, which feed information as to enemy plane operations in to military headquarters in the United States. The information is registered on radar screens to aid our co-ordinated defense operations as determined by the Air Force Top Command.

In order to provide a large picture of the individual radar screen receiving the information from each or all specific areas where enemy operations are taking place, an enlarged image is projected on a motion picture screen. This permits observation from moment to moment by the entire supervising command group.

A motion picture film record is made of the specific radar screen in question and this is immediately developed and projected on the viewing screen. To provide the high brightness required to produce a clear picture on the screen, as well as long lamp life, the mercury-xenon short-arc lamp was selected and the 1000-watt size is now used in the SAGE projection apparatus. This lamp produces a 10-foot square image for viewing by the coordinating technicians. It has approximately the same color and brightness appearance as the radar screen itself.

The optical system developed for the SAGE projector is of extremely high efficiency. It consists of a series of quartz miniscus condenser lenses with a high acceptance angle, producing a high intensity of light of uniform brightness on the motion picture film at the film gate. A precision spherical mirror behind the lamp increases picture brightness about 50 per cent. The objective or projection lens then throws an image of the picture on the screen.

Photocopy Applications

A letter or a mechanical drawing of a machine part can be quickly duplicated by use of photographic or diazo paper, and the widespread use of this process is speeding up the dissemination of information in modern American business. Most photocopy work today is carried out in a manner similar to that of the old-fashioned blueprint machine which utilizes light sources of extended dimensions. Microfilm filing, however, is gradually taking over and easing the filing burden so it becomes more and more necessary to reproduce the information recorded on a microfilm file picture. This requires a high intensity small source of light and brings the short-arc lamp into the photocopy field.

Fundamentally, photoprinting with a short-arc lamp from microfilm is similar to the projection of a motion picture on a screen. The principal difference is that the image is only enlarged to standard letter size whereas in picture projection the image is many times larger. The image may be focused on photographic paper, diazo paper, or on an electrostatically charged selenium drum.

Photographic paper has high sensitivity to light and an enlarged print can be made quickly with incandescent filament light sources or short-arc lamps. For maximum speed and clarity the short-arc lamp is preferred. Diazo paper has a "speed" of only one-millionth of that of photographic paper and therefore a high intensity arc light source is required. Carbon arcs have been used but a more convenient bulb type light source is preferred. The short-arc mercury or mercury-xenon lamp is gradually entering the field.

For diazo paper an auxiliary optical reflector

mounted behind the light source is recommended in order to obtain the maximum intensity of light at the film gate or aperture. Also, in some cases the lamp is temporarily overloaded during the exposure. The condensing lenses should be designed to receive and use the maximum possible amount of light flux and quartz lenses are recommended.

The objective or projection lens should have maximum efficiency and effectiveness to create the most brilliant possible image on the printing paper. Since diazo paper is most sensitive in the near ultraviolet the very high power in the 3650 A ultraviolet spectrum line of mercury is most important. The condenser lenses and the projection lenses should all be of quartz or of special glass with a high transmission in the near ultraviolet.

Photocopy by electrostatic deposit of ink on white paper results in high quality reproduction of printed material and also of microfilm records. A selenium drum is charged negatively. As the drum rotates an image of the microfilm record is projected onto it. Where the light strikes the charged selenium surface the electrical charges are removed but the charges remain where the black image areas fall. The drum then rotates to a point where black carbon ink particles are dusted onto it. They adhere to the charged areas of the drum and are then transferred to the paper used for the photocopy print. The carbon granules are permanently bonded to the paper by radiant heating.

The electrostatic system can be run at low speed with tungsten filament lamps but short-arc lamps are required for maximum speed and for maximum clarity in the finished print. The optical system is similar to that used for diazo prints.

Short-arc mercury lamps are also being applied to the electrostatic developing process whereby an image is projected to a rotating negatively charged selenium drum by reflection. The optical system is designed to project a high intensity strip of light across the original letter or print. This strip of light is slowly moved across the face of the original copy. The brightness of the strip must be extremely high, in order that the image on the drum will be created with a high degree of clarity, and must be sufficiently bright to discharge the drum in a minimum length of time. This application now utilizes the high brightness and small light source of short-arc mercury and mercury-xenon lamps.

Photochemical Applications

In heavy chemical industries the absorption of light can be made to alter the character of the chemicals which absorb it. This process makes possible the creation of new chemical products which in many cases can not be made in any other way. For example, today many insecticides are made by irradiating mixtures of chlorine gas and basic chemical elements. The light causes the chlorine to combine with the other chemicals and the result is a new useful compound. An example is hexachlorbenzene which is the present standard insecticide for use against the boll weevil.

The short-arc mercury or mercury-xenon lamp in photochemistry is new. The radiations are similar to those produced by the extended source lamp now used in blueprinting or photochemistry except that the light rays from a short-arc lamp can be controlled. Extended sources produce diffuse illumination which can be applied to a surface but cannot be directed.

When a photochemical process requires essentially parallel rays of light or of ultraviolet energy, the short-arc lamp is the answer. A good example is when the negative print or the pattern cannot be pressed directly against the print paper or surface involved. With extended light sources the negative and the positive are quite often pressed together in

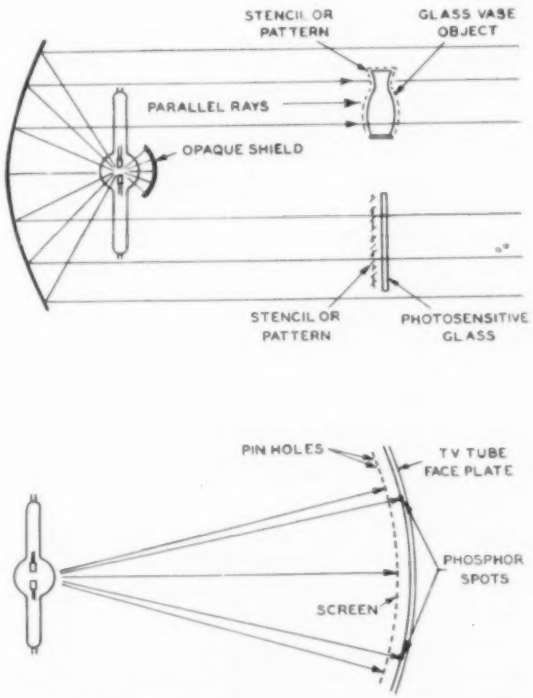


Figure 8. Photocopy and photochemical uses of mercury short-arc lamps require image or shadow technique. To enlarge and print microfilm, an image device is used. For etching designs in glass, the large searchlight produces parallel rays and sharp shadow patterns.

a "vacuum frame." This prevents light from getting between negative and positive and provides the direct contact of the two required for a clear print. Where the negative and the positive cannot be pressed directly together, and the print must be clear without blurring, the light rays must be essentially parallel. With a short-arc lamp this is possible and practical.

One of the best examples is the printing of designs on photosensitive glass. Sometimes the patterns cannot be pressed against the surface but the light rays must cast a sharp shadow in order to produce a sharp image on the glass. The optical system used involves a short-arc light source mounted at the focal point of a parabolic mirror. This develops essentially parallel rays of light which when they strike the pattern develop a sharp unblurred image.

Another excellent example which also utilizes photosensitive glass is in the manufacture of a television tube end plate for color television picture tube. Each tube contains a separation screen with thousands of minute holes. This screen is placed between the electron gun and the end plate which carries the fluorescing phosphor. For color pictures the requirement is that three tiny spots of phosphor be deposited opposite the holes of the separation screen. They must be so located that when the red electron gun fires the electrons will go through the hole and impinge upon the red fluorescent powder. Similarly when the green electron gun fires the electrons will pass through the hole and strike only the green fluorescent material, and finally, when the blue gun fires the electrons will cause the blue phosphor to fluoresce. Each separation screen and each television tube end plate must be matched. The best way to do this is to substitute a short-arc light source for the electron gun and to develop the phosphor deposits optically through the reaction of the light and ultraviolet rays on photosensitive glass used for the tube end plate. This results in precision of phosphor deposit and is the newest and most interesting use of short-arc lamps.

Conclusion

Short-arc mercury and mercury-xenon lamps are invading the field of optics today, chiefly because they are high brightness "point sources" of light that operate simply and consistently like an incandescent lamp. First developed for military purposes they now promise to solve optical problems that never could be solved before. These range from that of increased accuracy of a laboratory instrument in a hospital to the addition of five miles range on a navigation searchlight on the Suez Canal.

DISCUSSION

S. C. PEEK:* Mr. Beggs and his associates did a remarkable job in their presentation of enclosed arcs. They must have spent long hours in preparation for the demonstration for such a smooth performance doesn't just happen. There is no doubt in my mind that the very bright light sources described will find many more uses than even the large number described. I would like to comment briefly, however, on the concept of point sources. I believe a more accurate word would be concentrated sources, for an infinitely small source would find no use even though it had extreme brightness. In most optical designs it is essential to use a finite area of emitted light and the uniformity and stability are important considerations.

E. W. BEGGS:** I wish to thank Mr. Peek for his nice words regarding our presentation.

The high current wiring provided by the hotel and the heavy transformers and high voltage starting apparatus that were necessary for our short-arc lamps were only visible on close inspection of the demonstration equipment. The fact that the lamps came on and off like clock work was the result of a lot of effort in the set-up and of several years of development in the lamp starting and ballast circuits, as well as improvements in the lamps themselves.

Regarding the use of the words "point source" it is true that there is no such thing and that is why I used the quotation marks. Everybody in the lighting business uses the term "point source" and so I chose to use it because it is familiar to most people. We have found that the best term to use to describe our lamp is "short-arc." It is a term that has been used elsewhere and in my opinion, it is more descriptive than other terms that have been suggested. It indicates that there are two electrodes with an electric discharge taking place between them so that immediately it conveys to the user the sort of optical, as well as electrical and mechanical factors that are involved in its use.

With regard to uniformity and stability, the term Short-Arc also helps the user visualize the sort of characteristics these lamps have. The arc stream varies somewhat in brightness but it is more uniform in this respect than incandescent tungsten sources. In searchlight work, for example, it acts like a ball of light. It is also quite steady, although being a stream of electrons in a gas it is not absolutely fixed like a tungsten filament. If it is desirable to completely eliminate the effect of the slight drift that may occur an image of the arc is projected on a plate with a small aperture. This aperture then becomes a steady fixed light source with high brightness and of predetermined shape and size as required.

*Sylvania Electric Products Inc., Salem, Mass.
**Author.

See list of Sustaining Members beginning on page 21A.

A.I.A. File No. 31

INSTALLATION AT
HIGHLAND PARK LIBRARY
HIGHLAND PARK, ILL.

Lighting a Library

LIGHTING OBJECTIVE: To provide comfortable general illumination for efficient seeing in the reading room of a public library.

GENERAL INFORMATION: The reading area shown is 32 feet by 80 feet with a ceiling height of 16 feet at the walls and 32 feet at the peak. Colors and reflectances of the major room surfaces are: ceiling, cream, 65% RF; beams, medium brown, 12% RF; walls, cream, 55% RF; bookshelves, oak brown, 15% RF; table tops, oak brown, 18% RF*; floor, brown and tan, 15% RF.

INSTALLATION: Eighteen Lighting Products Inc. Panelux luminaires, catalog No. 874K6-96, are suspended 14 feet above the floor in 6 rows spaced on 12-foot centers. There are 3 luminaires, joined end to end, in each row, forming 4-foot by 24-foot patterns. Each luminaire is provided with a ⅝ by ⅝-inch cell polystyrene louver diffuser, providing 45-degree shielding, and is equipped with six 96-inch T-12 slimline lamps, three standard cool white alternately mixed with three deluxe warm white.

The average level of illumination after 800 hours operation was 45 footcandles. Brightnesses at that time were:

luminaire 45° crosswise	450 fL	walls	25 fL
45° lengthwise	390 fL	table tops	8 fL
ceiling above luminaires	50 fL	floor	6 fL

*Below I.E.S. Recommended Practice.

Lighting designed by Edwin D. Tillson, 2507 Lincoln Ave., Evanston, Ill.; Contractor: Highland Park Electric, 2254 Skokie Valley, Highand Park, Ill.

Lighting data submitted by Don Davis and M. McCreight, Lighting Products Inc., Highland Park, Ill., as an illustration of good lighting practice and to aid in the design of similar installations.

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Series XXII 1-58

A.I.A. File No. 31

Glow Discharge Characteristics Of Fluorescent Lamps

By C. J. BERNIER
W. C. GUNGLE

THE FLUORESCENT lamp, since its introduction, has enjoyed phenomenal acceptance by the lighting industry for lighting large areas, particularly office or factory locations. This acceptance has been due almost entirely to its high efficiency and low surface brightness. However, this low brightness may have some disadvantage for floodlighting applications, such as parking areas, tunnel areas and high bay factory areas, where it is desired to direct and control high lumen light distribution by suitable luminaires. For these types of applications there has been a demand by lighting engineers for a fluorescent lamp yielding a much higher light output.

Two avenues of approach are open to lamp manufacturers for obtaining a satisfactory product for these applications. They are: (1) use of more efficient phosphors for converting ultraviolet to visible light; (2) increase in the ultraviolet output of the low pressure mercury are within the lamp.

The potential gain in light available from more efficient phosphors is not great, since at present 95 per cent of the generated photons of u-v radiation are converted into visible light by the phosphor. This leaves us with the problem of increasing the amount of u-v generated in the lamp. The straightforward approach would appear to be an increase in the power input to the arc. However, increases in power input are associated with increases in mercury vapor pressure to values above the six micron level, at which the radiation of u-v is at a maximum; thus further increases in power levels as such do not lead to increased generation of ultraviolet. As shown in a previous paper,[1] the mercury vapor pressure in a fluorescent lamp can be made independent of power by maintaining a small portion of the bulb surface at 40° C. There are presently two lamp designs on the market utilizing such control of mercury vapor pressure. In addition, choice of the proper type and pressure of fill gas will result in further improvements in efficiency at very high power loadings.

Practically all new fluorescent lamps introduced over the past few years have been designed for the rapid start circuit.[2] This circuit has many advantages over those employing preheat or instant starting, but certain deleterious effects are present even in normal operation, which become more apparent when the power input to the lamp is increased. If abnormal operating conditions are encountered these deleterious effects are greatly magnified and can result in the destruction of a lamp in a very short time.

This paper presents a study of certain phenomena occurring in lamps operated on a rapid start circuit with particular reference to the behavior of high power lamps. Through this study a better insight has been obtained into the behavior of lamps of any power operated in this type of circuit.

Idiosyncrasies of the Series Sequence Rapid Start Circuit

In general, all good things are accompanied by some minor disadvantages. This is true of the rapid start system of lamp operation. One of these disadvantages is that a demand is set up for electrons from the cathode prior to the time when a copious supply can be emitted from the heated filament. This is the result of the application of lamp starting voltage at the same time as the application of lamp filament voltage.

The first step in starting a fluorescent lamp is ignition of a glow discharge having a positive volt-ampere characteristic. Conversion of this glow discharge to an arc discharge requires: (a) sufficient voltage from the ballast to carry the lamp over the maximum in the characteristic curve, and (b) sufficient electron emission from the cathode to provide the current demanded by the arc as limited by the ballast characteristic. In the instant start circuit the voltage provided by the ballast is sufficiently high not only to start a glow discharge but

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: Sylvania Electric Products Inc., Danvers, Mass., and Salem, Mass., respectively.

immediately to convert this to an arc discharge since heating of the cathode by ion bombardment provides sufficient electron emission in a fraction of a second.

In the usual series-sequence rapid-start circuit, the ballast provides sufficient voltage to start the glow discharge, but not sufficient to effect the transition to the arc discharge if the cathode is heated by ion bombardment alone. Consequently, between the time of ignition of the glow discharge and the time when the cathode becomes sufficiently heated to provide ample thermionic emission there is an interval during which a high cold cathode current is drawn. During this glow discharge phase of lamp starting the current to support the discharge is supplied by cold cathode emission and this in turn results in a cathode fall as high as 100 volts. The magnitude of the current during the glow discharge is a function not only of the external circuit, but also of the area available to act as cold cathode and ranges from 30 ma to as high as 500 ma on the very high output lamps, where considerable metal area is present. As will be discussed later, continued operation in a glow discharge can result in lamp failure within 20-40 hours.

After the arc has been established, proper operation of this system with the present design of ballasts and cathodes, requires that the filament voltage be maintained at a value equal to or greater than 3.4 volts to insure adequate thermionic emission. Since this voltage is small in magnitude, a decrease as little as one volt results in a large percentage change in filament voltage and consequently filament temperature. A decrease of this order of magnitude in effective filament voltage can readily result from poor regulation in the ballast or from poor contacts in the lamp holder. If thermionic emission is inadequate, some cold cathode emission continues.

The disadvantages of the rapid start circuit outlined above are found with all lamps operated on this type of circuit but the difficulties are markedly accentuated for lamps operated at higher loadings. In addition, it should be emphasized that the rapid start system has many attributes which more than outweigh these disadvantages.

Design Differences of Various Rapid Start Lamps

A review of the design of rapid start fluorescent lamps introduced during the past six years shows various trends in lamp construction. Table I gives such a review.

The first trend evident is the tremendous increase in lamp loading from 10 watts per foot to 25 watts per foot. Along with this increase in lamp loading to 25 watts per foot a complete change has been made in the gas fill. As shown by Waymouth et al,[3] for loadings of the order of 15 or 20 watts per foot, the light output from a conventional T-12 lamp filled with argon approaches a plateau such that further increases in loading result in progressively decreasing gains in light output.

The light output asymptotically approaches a limit independent of loading. This limit or ceiling of light output can be raised by effecting an increase in the electron temperature of the discharge. Higher electron temperatures can be realized by reducing the effective bulb diameter, by reducing gas or mercury vapor pressure, or by increasing the ionic mobility in the discharge.

The ionic mobility of mercury ions is highest in helium and decreases with increasing mass of the fill gas through neon, argon, krypton and xenon. Thus the electron temperature of a conventional T-12 lamp can be increased by a simple change in the fill gas.

As mentioned above, the electron temperature of a fluorescent lamp can also be raised by changes in bulb geometry to give reduction in effective bulb diameter. If only this means is used it would be necessary to change bulb geometry for each change in loading to realize acceptable results. As shown by Gungle et al[1] with a change to a neon fill, loadings as high as 50 watts per foot in a conventional T-12 lamp result in efficiencies greater than 50 lumens per watt for an eight-foot lamp. VHO lamps made with conventional T-12 bulbs, use a fill gas containing a high percentage of neon. This results in a higher ionic mobility and associated higher electron temperature than with argon filled lamps and consequent higher efficiency at high loading. It will also be noted that, along with increases in lamp loading and change of fill gas, the lamp fill pressure has been lowered progressively with the object of decreasing the losses due to elastic collision between the electrons and the atoms of the fill gas. All of these changes have resulted in less and less protection from ion bombardment being afforded the cathode. As a result of this lower cathode protection, and of the higher currents demanded by the increased power input to a lamp, more stringent requirements are placed on filament design and also on the design of ballasts to insure that proper filament temperature is maintained not only at starting but also during lamp operation.

Another trend shown in Table I is the increase in area of metal surfaces in the vicinity of the cathodes. These metal surfaces when connected to the lamp circuit may act as cold cathodes providing a

TABLE I.

	Current Amperes	Arc Watts/ Foot	Millimeters Fill Pressure	Fill Gas	Exposed Metal Parts
40T12RS	.425	10	3.0	Argon	Support wires
96T12RS	.830	15	1.5	Argon	Support wires + probes
VHO25RS	1.300	25	1.0	Neon	Support wires + probes + disc

sizeable percentage of the electrons during the period of glow discharge operation, and after the arc has been established these metal parts will carry a fraction of the total lamp current. As the total surface area of the exposed metal increases, the magnitude of the current flow to and from the metal increases during both glow and arc operation. When the lamp is conducting current during a period of cold cathode operation, the cathode fall is of the order of 100 volts. This would have no deleterious effect if the metal parts simply acted as electron emitters. Unfortunately, positive ions moving through the high cathode fall bombard the metal with high energies resulting in sputtering of the metal. This sputtered metal leaves the surface in all directions and deposits on the first surface it strikes during its travel. This includes the cathode coating on the filament. As sputtered metal covers the cathode coating, the electron emission from the coating decreases until the level of electron emission is not sufficient to satisfy the current requirements of the ballast. The lamp is then a failure. While the sputtering due to positive ion bombardment is much more pronounced during operation in the glow discharge, it can also occur during operation as an arc and in this case both gas pressure and gas type have a considerable effect.

Starting Characteristics of VHO Lamps

As pointed out above, a glow discharge is set up in a fluorescent lamp during each start prior to transition to an arc and this glow discharge persists in rapid start lamps during the interval while the filaments are being heated to operating temperature. The characteristics of this glow discharge are significantly different from those after the arc has been established and a more detailed study was required to establish why continued operation in the glow can be ruinous to a cathode in a relatively short time. This was done on a lamp which had separate leads to the cathode coil and to the metal parts acting as anode. A probe, consisting of a glass beaded dumet wire, was inserted into the bulb wall in the vicinity of the filament. This probe was used to measure cathode fall. The circuitry used in making these measurements, shown in Fig. 1, was such that the electron current to the anode was eliminated. The upper oscilloscope trace in Fig. 2 shows the floating potential of the probe during the starting cycle. The potential measured by this probe is approximately equal to the cathode fall. In this figure the horizontal axis is time with a scale of one second per ordinate, while the vertical axis is voltage with a scale of 20 volts per ordinate. It can be seen that during the starting cycle, the voltage must be higher than 80 volts since the peak of the trace is not shown on the photograph. The maximum value of this cathode fall during starting is affected somewhat by the type and pressure

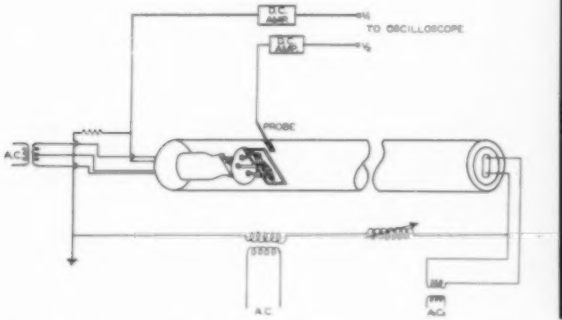

Figure 1. Circuitry for measuring cathode fall and ion current during starting of a fluorescent lamp.

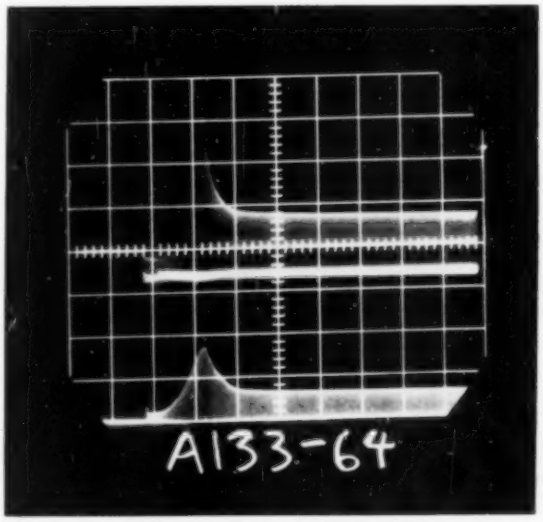

Figure 2. Oscilloscope traces of cathode fall, and ion current flow to an auxiliary anode during lamp starting.

of fill gas but this effect is relatively small and in all cases an extremely high cathode fall is found for a short time during the starting cycle. The lower trace on this same photograph with a scale of 100 milliamperes per ordinate shows the positive ion current falling into the anode during the half cycle in which the end of the lamp being observed is acting as cathode. It will be noted that a large ion current flows to the anode during this starting cycle. The energy at the time of the peak of the ion current amounts to approximately 12 watts and is dissipated at the anode resulting in severe sputtering of the metal.

Operating Characteristics of VHO Lamps

When a lamp has passed through the glow state into an arc the cathode phenomena are quite different. The coil temperature has increased to approximately 950° C and the coil can therefore supply a sufficient number of thermionic electrons to the discharge. During the transition from the glow to the arc the cathode fall drops rather quickly from a value greater than 80 or 90 volts to a value less than 20 volts. In operation as an arc, contrasted to operation as a glow, the limiting value of the cathode fall depends quite markedly on the fill gas and on the temperature to which the cathode is heated. Fig. 3, where the peak cathode fall during the cathode half cycle is plotted as a function of voltage applied to the filament for three different gas fills (neon, argon and a mixture of neon and argon) shows these effects. In all cases the maximum value of the cathode fall occurs with no external filament heat.* With argon fill the maximum value of cathode fall is approximately 12 volts, while in the case of neon fill the maximum value of cathode fall is considerably higher. This unexpected difference in behavior of argon and neon is apparently due to a fundamental difference in behavior of these two gases.

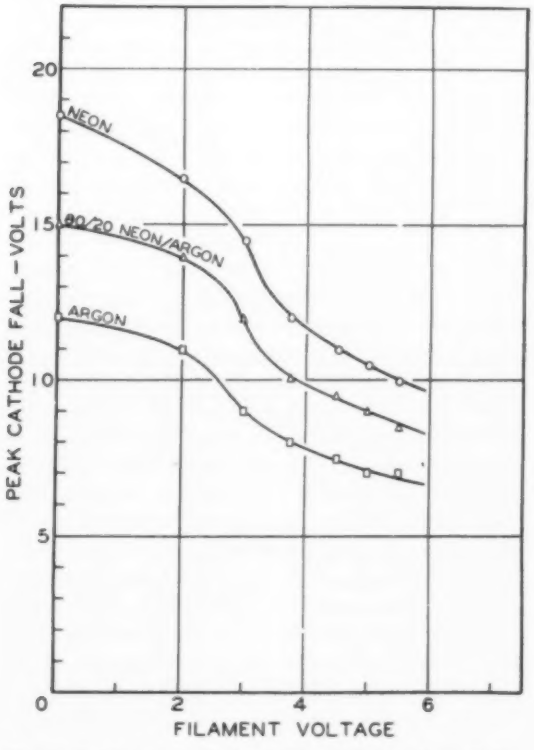

Figure 3. Curves of cathode fall as a function of filament voltage for 1.0 mm argon fill, 1.0 mm 80 per cent neon/20 per cent argon fill and 1.0 mm neon fill.

For this condition of no external filament heat, the filament is heated essentially by ion bombardment. Since there is a difference of cathode fall depending on the fill gas, it appears there are insufficient mercury ions bombarding the filament to produce optimum temperature for good electron emission. The fill gas is the only other constituent of the lamp from which more bombarding ions can be obtained. Fill gas ions are probably produced by two-stage ionization, *i.e.*, the first inelastic collision between an electron and gas atom results in excitation of the gas atom with a second collision resulting in ionization of the excited gas atom. Fig. 4, which is a plot of "probability" of inelastic collision as a function of voltage, gives curves for excitation and ionization in argon and neon. This "probability" of inelastic collisions is a measure of the number of exciting collisions per unit path length. Under conditions of two-stage ionization, the number of exciting collisions per unit path length is a measure of the number of ions formed per unit path length. Thus, the probability as plotted in Fig. 4 is a measure of the number of ions produced per unit path length. To realize a "probability" of 0.15 with an argon fill a potential of 11.5 volts is required; to obtain this same probability in a neon fill a potential of 18.0 volts is required, *i.e.*, a much higher potential must exist in neon to obtain a like number of ions as in argon at a considerably lower potential. This qualitatively explains the difference found for the peak cathode fall associated with a neon fill and argon fill arc discharge.

Again referring to Fig. 3 it can be seen that the maximum value of cathode fall, which is 18.5 volts for pure neon, can be reduced significantly by the addition of a small quantity of argon. As shown the addition of 10 per cent argon to neon results in

*Cathode fall was measured as a function of phase angle by a pulsed-probe technique developed by J. F. Waymouth of our laboratories.

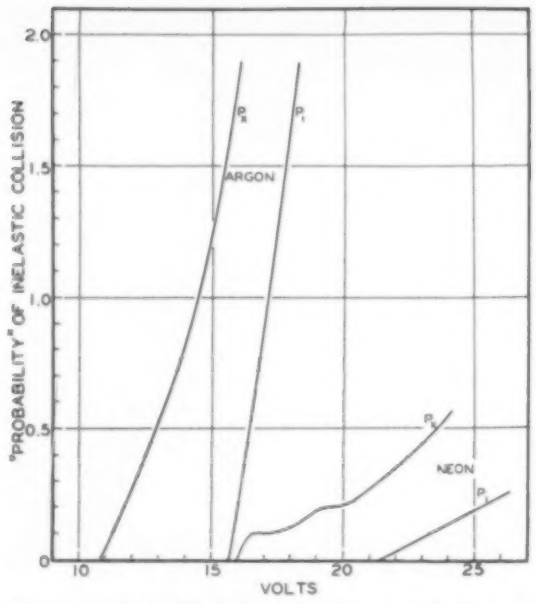

Figure 4. Probability of excitation and ionization of neon and argon.[4]

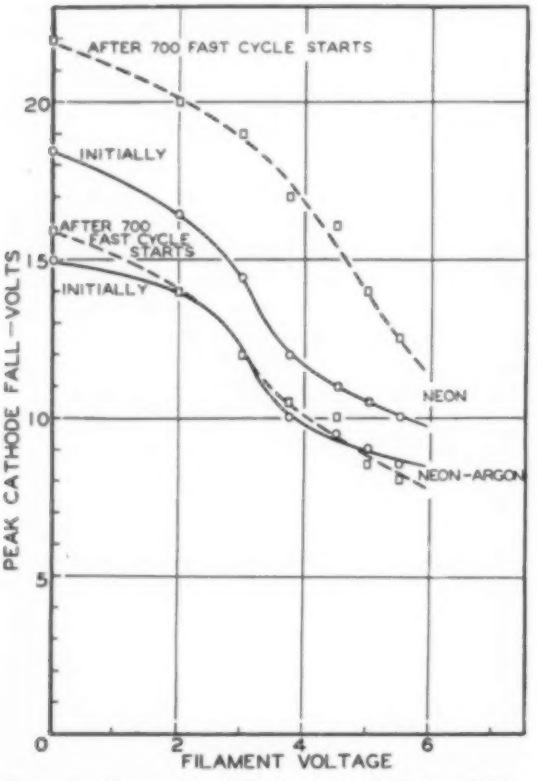

Figure 5. Curves of cathode fall as a function of filament voltage initially and after 700 "fast cycle" starts for 1.0 mm neon fill and 1.0 mm 80 per cent neon/20 per cent argon fill.

a maximum fall halfway between that of pure argon and pure neon. This variation in cathode fall with gas composition found with no filament heat is reflected in the cathode fall for normal values of filament voltage. With this minor addition of argon, there is essentially no change in the overall high efficiency obtainable with a neon filled fluorescent lamp operated at high loadings even though a significant reduction in cathode fall is realized.

In a further study of the change of cathode fall during various times of lamp life, a force test was used. This test was a fast on-off cycle which was three minutes in length with one minute on and two minutes off. This type of force test was found to give an indication of what occurs after various times of lamp operation but it cannot be used to predict life with any accuracy.

The results shown in Fig. 5 for the variation of cathode fall are quite interesting. In this figure the peak cathode fall is shown as a function of filament voltage for two different fill gases with curves being given for new lamps and for lamps which had been given 700 fast cycle starts. The experimental error in the data is of the order of one-half to one volt. When neon is used as the fill gas, a considerable increase in the cathode fall results from the fast cycle operation. With a mixture of 20 per cent argon and 80 per cent neon as the fill gas, 700 fast cycle starts cause no appreciable alteration in the cathode fall. Thus, the cathode fall can be maintained essentially constant with operating time even though the lamp is given repeated starts, if a small quantity of argon is present. The effectiveness of this small amount of argon is due to the limitation of cathode fall resulting in a decrease of the energy of the ions bombarding the exposed metal parts. Because of this decrease in the energy of the ions the sputtering is much less severe and less metal is deposited on the cathode coating. This decrease in the ion current is shown in Fig. 6 where curves are given for the ion current as a function of filament voltage. The operating conditions under which these measurements were made were essentially the same as those used for the oscilloscopic data of Fig. 2 so that the ion current measured is that flowing to the exposed metal parts adjacent to the cathode under consideration. With both new lamps and with lamps given 700 fast cycle starts the ion current is much lower when argon-neon fill is used than when the fill gas is neon. Thus a small amount of argon results in a second definite advantage. From other data, not presented here, the ion current in pure argon varies approximately as shown for the mixed gases. Although the fast cycle operation of a lamp

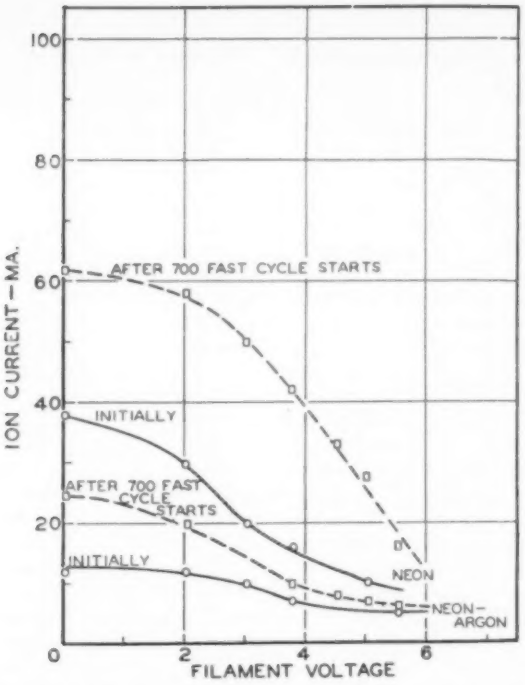

Figure 6. Curves of ion current flow as a function of filament voltage initially and after 700 "fast cycle" starts for 1.0 mm neon fill and 1.0 mm 80 per cent neon/20 per cent argon fill.

results in a considerably higher ion current than occurred initially, this current can be reduced to the initial value if the lamp is burned continuously for one to three hours.

The anode fall in an arc discharge has a negative, positive or zero field depending on three parameters. These are (1) random electron current in the discharge, (2) area of the anode, (3) magnitude of the current to be collected. In a neon filled lamp the random electron current in the discharge is significantly less than that of a lamp having an argon fill at the same discharge current. In fact, the random current of a VHO lamp filled with neon is approximately equal to that of a 40-watt lamp filled with argon. In contrast the current to be collected by the anode in a VHO lamp is three times that which must be collected by the anode in a 40-watt lamp so that the anode area for the VHO lamp must, of necessity, be at least three times the area used for anode in the 40-watt lamp if a high anode fall is to be avoided. From the standpoint of sputtering due to ion bombardment of exposed metal during the starting operation, it is necessary to reduce the metal surface in the vicinity of a cathode to a minimum. Since these two considerations are diametrically opposed it is apparent that methods other than reduction of anode area must be used to eliminate sputtering, or else a compromise must be made.

Methods of Reducing Sputtering In Neon Filled Lamps

A number of changes can be made in lamp construction which result in practically eliminating the effect of sputtering. Just in front of the region of cathode fall there is a region called the "Faraday dark space."[5] In this dark space the electron energies are quite low resulting in a low density of ions. An anode placed in this region as contrasted to the region of the negative glow or high ion density around the cathode should have far less ions falling into it. Measurements of ion current to an anode placed in the "Faraday dark space" have been made and found to be somewhat less than 10 ma regardless of area of the anode, just as expected. Thus if exposed metal parts serving as auxiliary anode to supplement the cathode area are placed in this region, little or no metal sputtering from this anode will occur. In addition due to the location of the anode in a region relatively remote geometrically from the cathode the chance of the sputtered metal landing on the cathode coating is also very much smaller than is the case when the anode is placed close to the cathode.

This still leaves the coil supports in the high ion density region near the cathode. The main purpose of these wires is to hold the filament or cathode. If these wires are covered with an insulating material, the cathode fall voltage appears across the insulator; the surface of the insulator is at floating potential which is only a few volts negative with respect to the negative glow. Therefore energies of ions striking it are relatively low and negligible sputtering of the insulator occurs. No ions, of course, can strike the metal support wire if it is fully covered by the insulator.

Conclusions

The advantages of neon over argon as a fill for highly loaded fluorescent lamps are significant. A better understanding of the role played by the fill gas in cathode phenomena of a fluorescent lamp has made it possible to retain the distinct advantages of neon, with its higher electron temperature and higher efficiency, while at the same time inhibiting the damaging effects of higher cathode fall.

Cathode falls sufficiently high to cause sputtering of metal surfaces may occur in any fluorescent lamp. These sputtered materials will plate the emissive material on the filament. As the emissive

material becomes covered, the emission properties of the material become inhibited.

Sputtering of metals in a neon filled lamp can be practically eliminated by the addition of a small quantity of argon to the neon, placing the auxiliary anode in the Faraday dark space and covering all other exposed metals in the negative glow region with an insulating material. Such modifications as these have allowed the distinct advantages of neon to be more fully realized in an improved version of the VHO lamp.

Acknowledgments

The authors wish to express their appreciation to the Product Development Group of the Sylvania Fluorescent Lamp Plant and Drs. K. H. Butler and J. F. Waymouth of the Sylvania Lighting Division Engineering Laboratories for their assistance in gathering data and preparation of this paper.

References

1. Gungle, W. C., Waymouth, J. F., and Homer, H. H.: "Operating Parameters of High Output Fluorescent Lamps." ILLUMINATING ENGINEERING, Vol. LII, p. 262 (1957).

2. Lemmers, A. E., and Brooks, W. W.: "New Fluorescent Lamps and Ballast Design for Rapid Starting," ILLUMINATING ENGINEERING, Vol. XLVII, p. 589 (1952).

3. Waymouth, J. F., Bitter, Francis, and Lowry, E. F.: "Factors to be Considered in the Design of High Output Fluorescent Lamps." ILLUMINATING ENGINEERING, Vol. LII, p. 275 (1957).

4. Brown, C., and Allis, W. P.: "Basic Data of Electrical Discharges," Massachusetts Institute of Technology, Research Laboratory of Electronics, Cambridge, Mass., p. 7 (1954).

5. See L. B. Loeb: "Fundamental Processes of Electrical Discharge in Gases," John Wiley and Sons, Inc., New York, N. Y., p. 566 (1939).

DISCUSSION

R. N. THAYER:* This interesting paper chiefly concerns serious performance problems that have apparently arisen in the highly-loaded fluorescent lamp design confidently described in last year's paper on "Operating Parameters of High Output Fluorescent Lamps" by Gungle, Waymouth and Homer. Our discussion of that paper then expressed considerable doubt on the ability of the lamp design then described to furnish satisfactory cathode performance and lamp life. The design modifications described in this new paper apparently confirm that view. These new design modifications undoubtedly result in improved lamp performance, but we may still question whether lamp life, lumen-maintenance, and required cathode heating wattage yet meet the standards of other fluorescent lamp designs.

All the principal design problems and modifications relate to electrode design and performance when neon is used as the fill gas. In this paper, the authors refer to the "unexpected" result that cathode fall is higher with neon than with argon. Why unexpected? Both the higher ionization potential and lighter atomic weight of neon would be expected to increase cathode fall, and so hot-cathode design and life have always proved troublesome in neon-filled lamps.

The paper refers to two different additions of argon to the neon, 10 per cent and 20 per cent, as reducing the cathode fall from the value with pure neon. Which value is used in their improved design? We would expect improvement in the direction which the authors indicate, but 100 per cent argon, of course, gives much lower cathode-fall. The absolute values of peak cathode fall in Figs. 3 and 5 appear three or four volts too low to us, based on our experience. Have the authors made allowance and correction for the tendency of a probe to run about this amount negative with respect to the space immediately around it?

Another design improvement stressed in the paper is the addition of an anode, located in the Faraday dark space. It is our general experience that anodes are required in high-current fluorescent lamps, but optional in low-current ones. Full coverage of the theory and practical experience in their design and operation is too detailed to cover here. The location of anodes well ahead of the cathode offers certain gains as described, but it may also result in a shorter effective arc gap, and in greater prominence of any end-discoloration arising from the anode. Actual lamp testing is required to determine whether a net gain results in lamp performance.

Lead wire insulation should help to minimize sputtering under cold-starting conditions, as the authors point out. It is an obvious requirement that the insulating material must adhere tightly to the wires throughout lamp life. Has this been determined?

Another discussion item relates to last year's paper on this same lamp design. An end-chamber at each end is intended to control mercury temperature and vapor pressure to the optimum value. Our experimenting during the year on lamps of this design has shown considerable difficulty in getting mercury to go to the cool ends and stay there, particularly when the lamps must be handled for measuring. It has prevented our getting reliable measures of initial and maintained light output and efficiency, despite careful handling. Do the authors have comment on this point?

In Table I, it may be convenient to add the appropriate data on the highly-loaded, rapid-start, power groove design, as follows: current, 1.5 amps.; arc watts/ft., 25; millimeters fill pressure, 1.4; fill gas, argon; exposed metal parts, support wires and probes (*i.e.* anodes). The argon fill gas, and the control of mercury vapor pressure throughout the tube length in this design eliminate the problems of neon gas and end chambers in the VHO design.

JAMES L. COX:* I wish to congratulate both Mr. Bernier and Mr. Gungle for a very interesting paper and useful data. This paper seems to indicate that the early troubles with the VHO fluorescent lamps have been solved.

The effect of argon in reducing cathode fall in VHO lamps is interesting but not entirely unexpected and is well known in the art of lamp making.

The authors refer to "small" and "minor" amounts of argon but apparently about 20 per cent argon is used for best results. With this rather large percentage of argon, does overall efficiency still remain essentially unchanged from the 100 per cent neon lamp? If so, why?

The authors show that a lamp containing Ne or 80 Ne/20 A shows a substantial increase in positive ion current after about 700 fast cycle starts and they state that this current returns to the initial value when the lamps burn continuously for one to three hours. Do the authors have an explanation for this?

Would the authors care to describe the (Waymouth) technique used for measuring cathode fall as a function of phase angle?

During the years of 1938 to 1940, I did considerable work

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*Duro Test Corp., North Bergen, N. J.

on insulating metal parts in the high ion density region using either glass or aluminum oxide. This proved successful in most cases, but was a costly operation and difficult to outgas, particularly in the region where the lead wires join the cathode. No doubt the authors have found a way to do this efficiently and economically.

H. U. HJERMSTAD:* Several references are made to the absolute necessity of maintaining a filament voltage of 3.4 volts or more during VHO25RS lamp operation. On new ballast designs this requirement can be kept uppermost in mind and design steps can be taken to fulfill this need.

On some ballast designs for 40T12RS and 825 ma RS lamps, filament voltages do drop appreciably below 3.4 volts during lamp operation. This occurs when the filament voltage supply windings are located over the secondary of a lag type ballast. Filament voltage supply windings have sometimes been located over the secondary for best utilization of available space. This had not been done in an attempt to circumvent the lamp requirements as specified by the lamp manufacturers. In fact, it was fully in accord with applicable ASA specifications which were drafted jointly by all major lamp manufacturers.

The ASA specifications establish no minimum filament voltage for 40T12 RS lamps during operation, only a maximum of 3.9 volts. The minimum of 3.4 volts applies only for the lamp open circuit condition with filament supply windings dummy loaded. The present specifications would allow zero voltage during normal lamp operation. To my knowledge, no lamp manufacturer has taken an exception to this condition. This specification is apparently wholly consistent with proper operation of 40T12 RS lamps.

Only recently has there been an expressed desire by any lamp manufacturer for a minimum filament voltage during operation of 825 ma RS lamps. The required minimum recently proposed within ASA technical committee circles is 2.5 volts for 825 ma RS lamps. So far, only one lamp manufacturer is the least bit insistent on a 2.5-volt minimum. This 2.5-volt minimum is apparently consistent with proper operation of 825 ma RS lamps. Before the recent agitation for a 2.5-volt minimum, zero voltage would have been consistent with proper lamp operation, insofar as information to the contrary from lamp manufacturers was concerned.

The crux of the whole situation is "awareness." Firstly, the lamp manufacturers must be aware of the requirement. Secondly, they must make the ballast manufacturers aware of the requirement. Thirdly, socket manufacturers must be made aware of this "new" requirement of maintained 3.4-volt minimum filament voltage during operation. It is conceivable that the accumulation of heat during operation could increase contact resistances during lamp operation.

Fourthly, fixture manufacturers must be made aware of this requirement so that the connections are correctly made in the fixtures. This is, after all, an innovation and everybody involved must be properly advised.

It is commendable that the requirement for minimum filament supply voltage during lamp operation of VHO25 RS lamps is coming to the fore in relatively early stages. If manufacturers of other type ultra high output lamps require this same consideration, it is hoped that they will be equally prompt and forthright.

With the proper exchange of information there need be no filament voltage during lamp operation lower than is consistent with proper operation of the VHO25RS lamp.

*Sola Electric Co., Chicago, Ill.

E. M. FREEGARD and D. LOVINGER:* The authors are certainly to be commended for the presentation of a very interesting and informative paper. Although the paper deals mainly with details of lamp construction and operating characteristics there are a few points which occur to the ballast manufacturer which may be worthy of mention.

The problem of obtaining proper cathode heating appears to be one of paramount interest to the authors. It seems obvious that a good deal of work has been done in connection with the development of this lamp using ballasts that are presently commercially available. We are sure that the authors appreciate that the amount of cathode voltage supplied is completely within the control of the ballast manufacturer who can provide more or less depending upon the requirements of the lamp. If a higher cathode voltage would in any way improve the operation of these lamps this can, of course, be supplied. This may be advantageous under the starting condition, but consideration of system efficiency under the normal burning condition may rule out this approach. If the lamp requires a high cathode voltage under the starting condition and a lower cathode voltage under the running condition, it may be possible that the ballast industry could develop a circuit utilizing bucking windings in series.

Although the ballast manufacturer can maintain a minimum of 3.4 volts across the cathode under the normal burning conditions, it should, however, be pointed out that the traditional one-half volt tolerance on cathode voltage delivered by the ballast may begin to unfavorably affect ballast economics with these heavily loaded lamps. No maximum voltage was specified by the authors and we hope that some voltage higher than 3.9 volts is being considered.

It may also be pertinent to mention that it may be possible for the ballast manufacturers to provide run cathode voltages of the order of 20 per cent to 60 per cent higher than the starting cathode voltage if this could be used to advantage by the lamp manufacturers.

The authors have stated that one of the problems associated with lamp starting is that the arc is struck prior to the time the cathode is able to provide, by thermonic emission, all the electrons needed to support the arc. It may be possible to minimize this effect, in a two-lamp series ballast, by reducing the microfarads of the starting capacitor and thus force the lamps to start slower.

Since the introduction of the first high output rapid start lamps, the ballast manufacturer has had the opportunity to learn a good deal about performance of these lamps on conventional ballasts. It has become evident that testing of the high output rapid start lamps is very difficult because of the tendency of these lamps to be extremely sensitive to temperature changes and draft. Have the authors any comments in this regard about these new lamps?

C. J. BERNIER and W. C. GUNGLE:** The extensive discussion of this paper certainly shows more than just passing interest in use of neon as fill gas of fluorescent lamps.

The limiting value of cathode fall in an argon filled lamp as the filament voltage is reduced is just slightly greater than the 11.6 volts excitation potential of argon. For a neon filled lamp, under similar conditions, the cathode fall would of course be higher with an expected limiting value very close to the 16.9-volt excitation potential of neon. In actuality, this is not the case, as the value for neon can become significantly higher.

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**Authors.

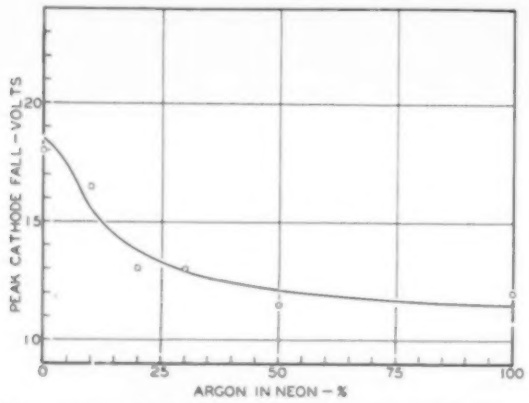

Figure A. Cathode fall as a function of argon in neon; solid line — calculated, circled points — experimental data.

The value of cathode fall in a mercury/rare gas discharge is dependent on several factors. The most important are:

(1) The excitation potential of the fill gas. This is of utmost importance for two-stage ionization as discussed in the paper.

(2) The probability of inelastic collisions. This factor is second in importance only to factor 1.

(3) The ionization potential of the fill gas, noted by Mr. Thayer. This is of importance when there is direct ionization which occurs under conditions of high cathode fall. Such values of cathode fall are seldom realized, except during starting.

While the curves of probability of inelastic collisions were discussed in the paper, the importance of this probability function in determining cathode fall potential was not recognized by some discussors. As shown in Fig. 4 of the paper, at a potential of 12.0 volts, the "probability" of excitation is about 0.15 for argon, while a potential of 19.0 volts is required to give the same probability with neon. These values agree quite well with experimental data such as shown in Fig. 3 of the paper for conditions of no external filament heat.

As mentioned above, it appears that a probability value for inelastic collisions of 0.15 is necessary to yield sufficient ions for bombardment heating of the cathode to a temperature for good thermionic emission. This is in the absence of external filament heating. Using this value of probability with the curves shown in Fig. 4 of the paper, the cathode fall as a function of argon in neon has been calculated. These quasi theoretical results are shown as the solid curve in Fig. A. Note the good agreement with the experimental data represented by the circled points.

The method of measuring cathode fall, for data reported in this paper was the pulse probe technique described at the 1953 MIT Physical Electronics Conference. In this method, the probe is maintained negative with respect to the cathode except for a brief instant during each cycle when it is pulsed positive. The current-voltage characteristic of the probe during this instant is displayed on an oscilloscope, and the "space potential" in the negative glow is identified from the sudden "break" in the current-voltage characteristic, as first described by Langmuir.[6] Since extensive measurements have demonstrated that the negative glow in these lamps is approximately an equipotential region, the potential of the probe can be identified with the cathode fall. The phase of the pulse can be adjusted over the entire cycle so that both anode and cathode fall can be measured as a function of phase. The accuracy of measurement of the absolute values of the peak cathode fall is approximately one-half to one volt. Within this error, the measured value of cathode fall is equal to 16.5 volts in pure neon when the filament voltage is reduced to the point where a red neon glow first appears at the cathode.

While the mass of the fill gas does not directly affect cathode fall, it can affect the rate of sputtering from the cathode. This is the result of optimum energy transfer taking place in a collision of particles having equal masses. The mass of neon ions is approximately equal to that of oxygen, which is a constituent of the cathode coating. Argon ions have a much larger mass than either neon ions or oxygen ions. Therefore, the rate of sputtering of cathode coating could be greater for neon ion bombardment than for argon ion bombardment of the cathode.

The phenomenon involved in the reduction of ion current during continued lamp operation is a matter of clean up of sputtered materials.

Overall efficiency of the improved VHO lamps is decreased something less than 4 per cent with no change in lumen output from the lamp. Of course, if the fill was changed to pure argon, a considerable loss in efficiency and lumen output would be incurred. There would be one compensating result; a further reduction of cathode fall, of the order of 8 per cent.

We appreciated the recognition by Mr. Thayer that the design modifications incorporated in the present VHO lamp as presented in this paper, undoubtedly result in improved performance. Of course, the insulating material on the lead wires must adhere throughout life, or sputtering of the metal lead would again take place. Due care has been taken to ensure the life of the insulation.

It was pointed out in 1956[7] that the stabilization process in the VHO type lamp is of longer duration than for conventional fluorescent lamps. The time involved is markedly dependent on the quantity of mercury in the lamp. A number of techniques can be used to reduce this time of stabilization, but the important point is to maintain correct ambient temperature conditions. This is critical with all heavily loaded lamps due to the power dissipated by the device. For photometric measurements it is a necessity to use caution in handling the lamps to avoid displacing the mercury after the lamp has been stabilized. This is strictly a photometric problem, as in normal use the lamps will be handled only during installation of new lamps.

The use of a high filament voltage initially could result in a shorter interval of lamp operation with high cathode fall. This high filament voltage in conjunction with bucking type filament windings to reduce this voltage during lamp operation would be worthy of investigation.

Initial studies have been made of time of lamp starting as a function of starting capacitance. These studies indicate no net advantage would be obtained by decreasing the value of the ballast shunting capacitor since the starting voltage is correspondingly increased.

As power input to fluorescent lamps has increased, the problems of optimum ballast design have also increased, and we are glad to see the need for closer liaison between lamp and ballast manufacturers is being discussed.

6. Langmuir, Irving: "The Interaction of Electron and Positive Ion Space Charges in Cathode Sheaths," *Physics Rev.*, 33, 954-989 (1929).

7. Gungle, W. C., Waymouth, J. F., Homer, H. H.: "Operating Parameters of High Output Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. LII, No. 5, p. 262-272 (May 1957).

Spectral Luminosity of Fluorescent Lamps

By CHARLES W. JEROME

SPECTRAL energy distribution of light sources is one of the fundamental data important in the full understanding of their behavior and operation. This is particularly true of fluorescent lamps where a wide variety of spectral distributions is available. Such curves appear in the literature of almost every publication dealing with these lamps and they are almost a requisite in those publications dealing with their color. (For example, see Sections 5 and 8, *I.E.S. Lighting Handbook*.)

From these fundamental data the color parameters for the C.I.E. color mixture diagram can be computed[1] and they lead to an insight into the rendition of colors effected by a particular lamp.[2] The brightness, *i.e.*, the lumen output, can also be computed from the spectral distribution and those who perform this computation frequently learn to visualize the effect of various spectral energy distributions on the brightness and color rendition. However, this is an acquired art and those who are not fully familiar with the principles involved find it difficult to make this evaluation mentally. It is the purpose of this paper to explain the basic principles involved in the computation of brightness from spectral energy curves and to show the results for the usual fluorescent lamp colors. A new method for roughly indicating the color rendering properties is also presented.

Theory and Experimental Data

The difficulty in converting energy into lumens arises from the non-uniform sensitivity of the human eye to various wavelengths. For example, the eye is most sensitive to radiation with a wavelength of 555 mμ. That is, a given amount of energy of this wavelength gives the greatest number of lumens, whereas, the same amount of energy at approximately 510 mμ or 610 mμ gives only one-half as many lumens, and radiation at 470 and 650 mμ gives only one-tenth as many lumens. Further, radiation below 400 or above 730 mμ (considering the practical limits of the visible spectrum) will yield no lumens whatever although the energy is of the same type, differing only in wavelength.

This varying sensitivity of the human eye to various wavelengths is shown in Fig. 1, the so-called "visibility function." To find the relative brightness of a given energy at a particular wavelength, E_λ, it must be multiplied by the visibility function, $\bar{y}_\lambda$, at that wavelength. And if the total energy is composed of a number of different wavelengths, those products must be determined for each and summed together. Or, in mathematical notation:

$$B = K \int E_\lambda \bar{y}_\lambda \, d\lambda.$$

where B is the brightness

and K is a proportionality constant whose value depends on the units of E_λ and the units in which B is desired. For example, when properly chosen, B can be obtained in foot-lamberts, or again directly into lumens for a lamp of specific geometry.

Therefore, if the product, $E_\lambda \bar{y}_\lambda$, is plotted as a function of wavelength, then the above expression indicates that the total area under the curve will be proportional to the brightness. That is, it is this curve which is of interest as far as lumen output is concerned rather than the more fundamental data of energy as a function of wavelength. Both curves are shown for the more usual fluorescent lamp colors in Figs. 2 to 7.

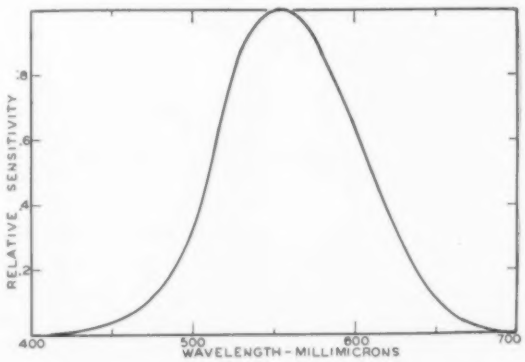

Figure 1. Spectral sensitivity of the human eye.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHOR: Sylvania Electric Products Inc., Salem, Mass.

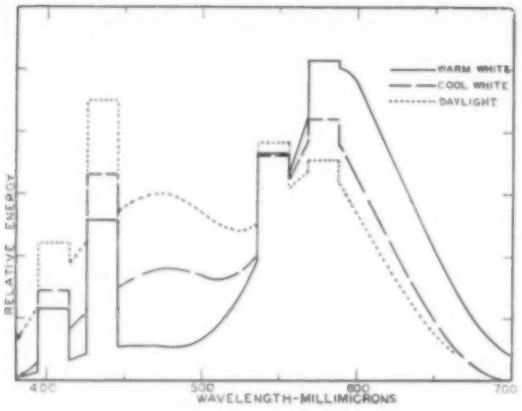

Figure 2. Spectral energy distributions — standard white fluorescent lamps.

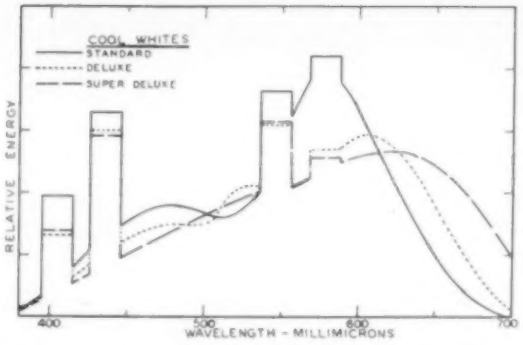

Figure 3. Spectral energy distributions — cool whites.

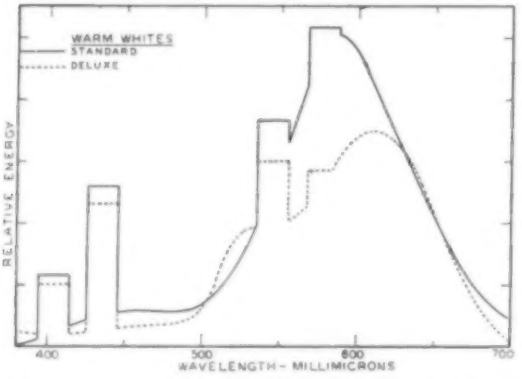

Figure 4. Spectral energy distributions — warm whites.

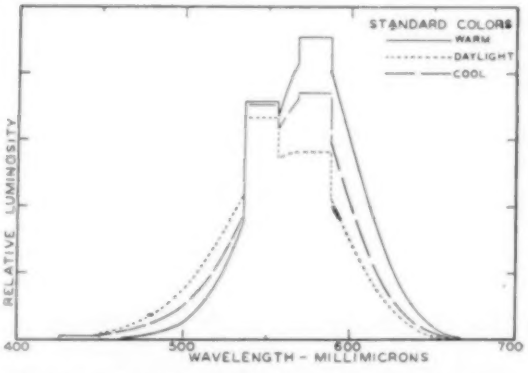

Figure 5. Spectral luminosity — standard fluorescent lamps.

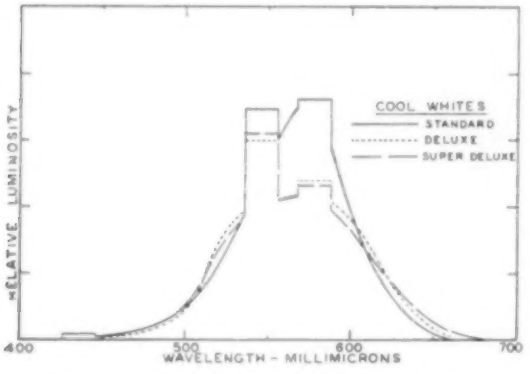

Figure 6. Spectral luminosity — cool whites.

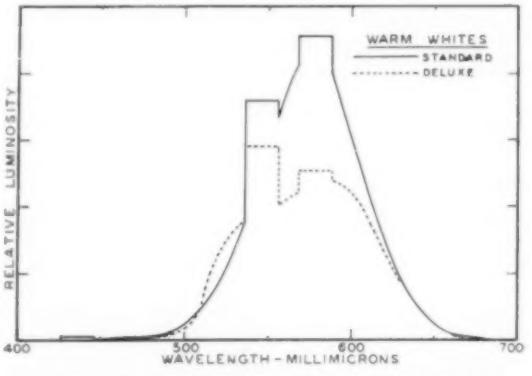

Figure 7. Spectral luminosity — warm whites.

Another method of presenting these data was developed by Butler[3] in which he plotted energy against a non-linear wavelength scale, the interval between wavelengths being proportional to the visibility function. This results in wide spacings in the middle of the spectrum around 555 millimicrons with the spacings getting narrower towards the ends of the spectrum. Such a presentation of the data for fluorescent lamps is shown in Figs. 8 and 9. In these figures, it can be seen that the area under the curves in any one block is proportional to the product, $E_\lambda \bar{y}_\lambda$. Therefore, this type of pre-

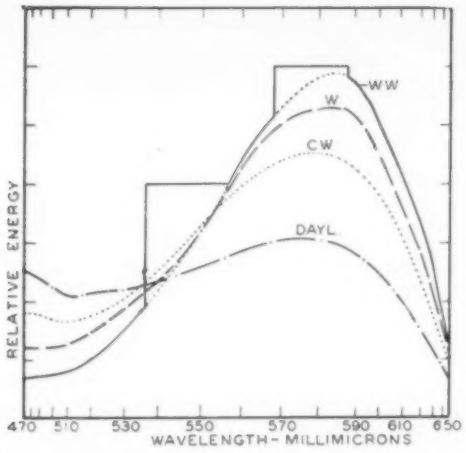

Figure 8. Spectral energy distributions of standard fluorescent lamps on visibility paper.

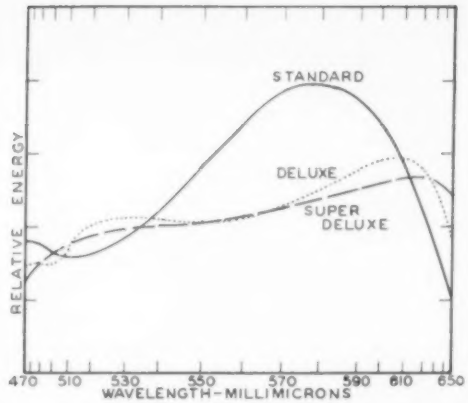

Figure 9. Spectral energy distributions of cool whites on visibility paper.

sentation also leads to curves in which the areas under them are proportional to the brightness just as those in Figs. 2 to 7.

The easiest way to arrive at the proper spacings for the wavelengths in Figs. 8 and 9 is to take the selected ordinates for y used in colorimetric computations[4] and space them at uniform intervals. This suggested performing the same experiment with the selected ordinates for the $\bar{x}$ and $\bar{z}$ functions. The spectral energy distributions of fluorescent lamps on these spacings of wavelengths are shown in Figs. 10 and 11. These figures, of course, tend to emphasize the red (x) and blue ($\bar{z}$) ends of

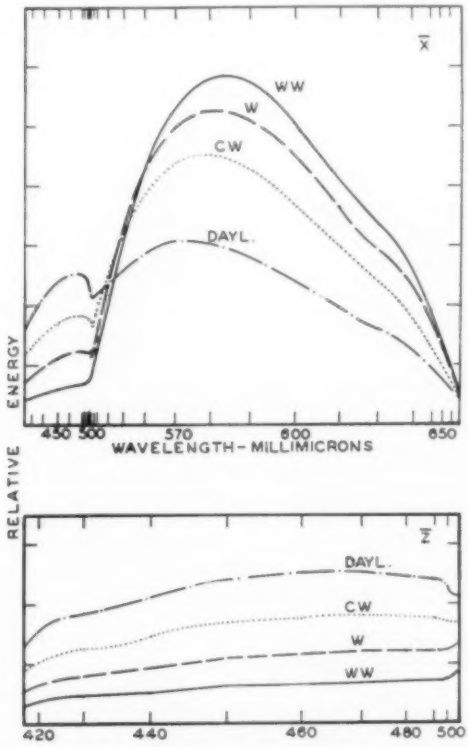

Figure 10. Spectral energy distributions of standard colors (phosphor only) on uniform scales for $\bar{x}$ (upper) and $\bar{z}$ (lower).

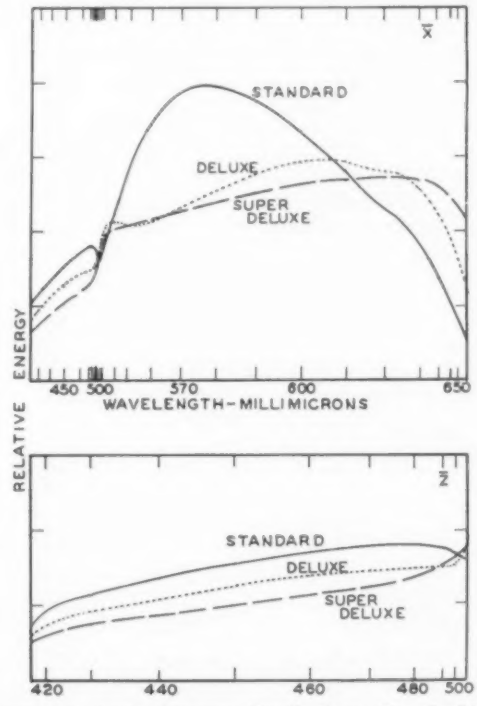

Figure 11. Spectral energy distributions of cool whites (phosphor only) on uniform scales for $\bar{x}$ (upper) and $\bar{z}$ (lower).

the energy spectrum. The ends of the spectrum are very important in the rendition of colors, especially the red end for fluorescent lamps. The presentation of spectral energy data in this form emphasizes the differences in these regions and makes their color rendition easier to evaluate. For example the upper portion of Fig. 11 shows clearly the increased red emission of the deluxe colors over that of the standard.

The blue end of the spectrum of fluorescent lamps has not caused as much concern as regards color rendition as the red end. This is because the blue end of the spectrum is dominated by two mercury lines, one at 405 and an even stronger one at 436 millimicrons. For example, if the 436 mμ line were shown on the lower portions of Figs. 10 and 11 in the conventional manner of bands 20 mμ wide, such a band would extend well up into the upper portions of those figures. It can be appreciated that this energy is on a par with the total energy emitted in this general region by the Daylight lamp phosphor, and is larger than that from the other white lamps. Since these mercury lines are common to all fluorescent lamps (except those with filter coats) this means that different types of fluorescent lamps differ less in this region than they do in the red end of the spectrum where there are no significant mercury lines. This explains why the interest in improving color rendition of these lamps is concentrated on improving their red emission.

Discussion

From the above data it should be apparent why, when the emphasis on fluorescent lamps is on high luminous efficiency, their spectral energy is kept to a maximum towards the middle of the spectrum while letting the energy fall away towards the ends of the spectrum. By this means, the most efficient use is made of the emitted energy in producing lumens.

These figures also show why the deluxe colors emit fewer lumens than the standard colors even though the total energy emitted by the lamps (areas under the spectral energy distribution curves) are very nearly the same. For example, in Fig. 3, comparing the spectral energy distributions of the Cool White colors, the excess energy of the standard Cool White above that of the Super Deluxe, especially in the vicinity of 580 millimicrons is balanced by the excess of Super Deluxe energy beyond 610 millimicrons. That is, these two lamps are giving off approximately the same amount of total energy. However, when the luminosities of these lamps are compared, Fig. 6, it is obvious that the excess energy of the standard lamp at 580 millimicrons gives rise to a large excess of lumens which is by no means balanced by the extra lumens of the Super Deluxe imparted by its excess energy beyond 610 millimicrons.

This same argument also holds qualitatively for a comparison of the standard and deluxe colors. However, the red component of the latter color, calcium silicate (Pb,Mn), has an emission band in the ultraviolet (not shown in Figs. 3 and 4). Therefore, although the total energies emitted by these two lamps may be the same, in the visible region the deluxe lamp has less energy because of its ultraviolet emission, and its luminous efficiency is less than its visible energy distribution would indicate. This effect is particularly noticeable in the comparisons of the energy distributions of the warm white colors, Fig. 4. The absence of an ultraviolet band in the Super Deluxe phosphor explains why this lamp comes so close to the luminous efficiency of the deluxe lamp despite its improved color rendition imparted by its greater red emission.

Conclusion

Data have been presented comparing the spectral energy distributions of present day fluorescent lamps and their spectral luminosities. It is hoped that these data will prove helpful to the lighting engineer in evaluating each of these lamps for any particular application he may have in mind.

References

1. Jerome, C. W.: "The Determination of Color Parameters of Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLV, p. 225 (1950).
2. Jerome, C. W., and Judd, D. B.: "Specification of Color-Rendering Properties of Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLVIII, p. 259 (1953).
3. Butler, K. H.: "The Design of Fluorescent Lamp Phosphors," ILLUMINATING ENGINEERING, Vol. XLIV, p. 267 (1949).
4. Committee on Colorimetry, O.S.A.: *The Science of Color*, Thomas Y. Crowell Co. (1953), Table 15, p. 273.

DISCUSSION

D. B. JUDD:* Years ago at the suggestion of the late Frank Benford I used as abscissa for plotting spectral reflectance a wavelength scale adjusted to make each interval proportional to the ordinate of the standard "visibility function" at the center of that interval. I found such plots helped to show the visual meaning of spectral-reflectance data, and it is interesting to discover that Butler and the author have found the application of this method to spectral-energy data also to be useful. It is evident from this paper that analogous plots based on the $\bar{x}$- and z-functions likewise make it easier to see immediately the chromatic meaning of spectral-energy data.

ARTHUR W. WEEKS:** Mr. Jerome's paper is an important

*Photometry and Colorimetry Section, National Bureau of Standards, Washington, D. C.
**Sylvania Electric Products Inc., Salem, Mass.

contribution to the understanding of the methods of color evaluation, particularly color rendition. The information is presented clearly and concisely, and merits the study of all lighting engineers who are concerned with quality lighting.

I would be interested to know whether Mr. Jerome believes that the color of a light source could be evaluated by measuring a series of bands, perhaps similar to the British eight-band method, by means of color-filtered cells and these data translated into a form such as he has presented. This might aid the person not completely familiar with color technology in his evaluation of the color effects of light sources.

C. N. CLARK:* The author has done a concise job of summarizing the relationship of spectral energy distribution to total lumen output, and some of the mathematical and graphical methods of representing this relationship. His adaptation of the "visibility paper" principle for weighting spectral distribution according to the C.I.E. $\bar{x}$ and z tristimulus value functions is a worthy contribution.

In Figs. 2, 3 and 4, upon which the remainder of the figures are based, the ordinates are given as "relative energy." Since the spectral curves in these figures all peak at different heights, I assume that they represent the total output by waveband of lamps of the same wattage on some absolute energy scale (energy flux per unit waveband per lamp). This would have to be the case in order for the areas under the curves in Figs. 5 to 7 and 8 and 9 to be in proportion to the lumen outputs of the various colors in lamps of the same wattage. One way to clarify the basis for the different curve heights in Figs. 2, 3 and 4 would be to label the ordinates "energy flux per lamp" or "energy flux per watt input." The corresponding labels for Figs. 5, 6 and 7 would be "luminous flux per lamp" or "luminous flux per watt input."

The method of plotting used in the top of Figs. 10 and 11 is of special interest because it indicates that energy flux in the deep red region (beyond about 650 μu) is of little importance in determining either lamp chromaticity or color rendition, compared to the light red region, say 610-650 μu. This follows from the fact that the wavelength scale becomes highly compressed between 650 μu.

Reading the relative heights of the three curves in the top of Fig. 11 at any given wavelength shows exactly the same relationship as is portrayed in Fig. 3. It has to, since in both figures the same energy values are plotted as a function of wavelength. Fig. 11 has no advantage over conventional energy *vs* wavelength plots, in comparisons of this type. However, one example of the advantage of Fig. 11 in visualizing differences in color rendition can be seen by first considering Fig. 3. Here, beyond 610 μu, the area between the standard and super deluxe curves appears to be about twice as great as the area between the standard and deluxe curves. One possible inference from this is that the super deluxe design should show twice the improvement that the deluxe design shows in rendition of red samples, compared to standard cool. The top of Fig. 11 provides a much more accurate interpretation of these spectral differences. Here, the areas of the deluxe and super deluxe curves above the standard curve beyond 610 μu are nearly equal, with the super deluxe being slightly the greater. This indicates that the super deluxe design should have only slightly better rendition of deep red objects than deluxe. This is exactly what our experiments and practical experience have shown to be the case.

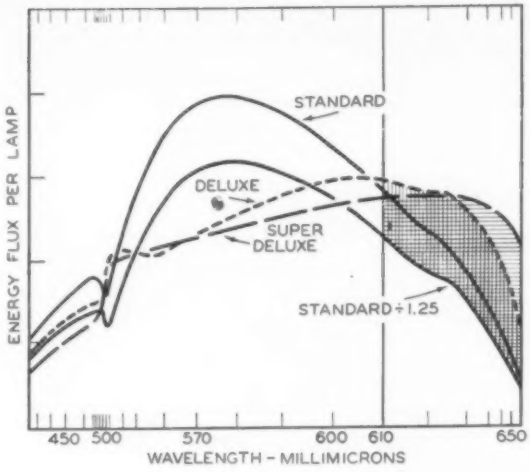

Figure A.

The validity and usefulness of Figs. 10 and 11 as rough indicators of lamp color rendering properties could be improved by dividing each energy distribution by the area under its spectral luminosity curve before plotting. This adjusts the energy distributions so that each represents the same number of lumens, and is analogous to the real side-by-side viewing situation wherein it is necessary to make the illumination from two different lamps equal on adjacent areas before visual color rendition comparisons are made.

The areas under the deluxe and super deluxe luminosity curves (Fig. 6) are about equal, but that of the standard is about 25 per cent greater. Therefore, in replotting (Fig. A) the top part of Fig. 11 for equal lumens, I have divided the standard curve by 1.25. Compared to the new equal-lumen curve for standard cool, the difference between super deluxe and deluxe in the red region is now smaller than when compared to the original standard cool curve. This implies even smaller differences in color rendition improvement between deluxe and super deluxe than did the original figure.

It may also be noted that if the curves for standard and deluxe warm white were to be plotted on the coordinates of Fig. 10 or 11 (top), the deluxe emission would at no point in the red region significantly exceed the standard. However, dividing both curves by their total luminosity would reduce the standard more than the deluxe, and allow one to visualize more readily the significant differences between the two in the red region.

In the next to last paragraph, the author implies that super deluxe lamps are nearly as efficient as deluxe lamps. Published data indicate that, in the 40-watt size, super deluxe is about 10 per cent lower in efficiency than deluxe. Our own experience with lamps of the super deluxe design is similar. This reduced output raises the question: Is the slight gain in rendition of deep reds that is obtainable with the super deluxe design of enough value to warrant accepting its lower efficiency? Our original conclusion, supported by subsequent field experience, is that the color rendition gain does *not* outweigh the efficiency loss.

*General Electric Co., Nela Park, Cleveland, Ohio.

C. W. JEROME:* I would like to thank the several persons who have contributed discussion of this paper. I was not aware of Dr. Judd's earlier use of the non-uniform wavelength scale. But, like him, we have found this type of presentation of spectral energy data very helpful in explaining the visual response to energy in various parts of the spectrum.

In answer to Mr. Weeks' question, the Donaldson colorimeter uses essentially this idea. It has six narrow band pass filters and undoubtedly could be made to use as many as might be desired. In its present form the Donaldson is a visual instrument, but could be modified to use photocells to measure the energy in the various bands. This, of course, is then a simplified spectroradiometer. To my mind, the reason why such simplifications are not more popular is one of economics. For example, a bona fide spectroradiometer would cost only four or five times as much as the simplified version but would yield ten or more times as much information. Therefore, most people interested in this sort of thing find it worthwhile to pay the extra price and obtain the more basic instrument.

Mr. Clark's comment regarding the labelling of the ordinates of the figures is well taken. These are all drawn to the same absolute energy (or luminosity, as the case may be) scale so that each curve shows the energy (or luminosity) at any wavelength relative to that of the other curves shown in the figures. A more specific label would undoubtedly be advantageous. However, the labels appearing on the figures were used for their simplicity after consideration of the space available.

In this paper I have been chiefly concerned with luminosity. The application of the presentations to color rendition is only incidental and cannot be considered to give a complete picture. For example, Mr. Clark's comment to the effect that energy flux in the deep red region is of little importance in color rendition is by no means true. It has been found that the energy at the extreme ends of the spectrum is particularly important in color rendition. This is illustrated by the reflectance curves of the metameric pairs of colors Dr. Judd used in the development of his Duplication Index.[1] (These are shown as Fig. 1 in Reference 2.) One of the major factors in the metamerism of these colors is their differences in the extreme red end of the spectrum. And it is this factor which makes them particularly efficacious in studying color rendition.

The answer to the question as to whether the improved red rendition of the super deluxe lamp as compared to the deluxe variety is sufficient to make up for its lower efficiency is, of course, one of personal choice. The number of customers who prefer one over the other is, I think, very evenly divided at this time, although it is my personal prediction that eventually the super deluxe will replace the deluxe in all applications where the proper rendition of colors is the primary consideration.

*Author.

1. Judd, D. B.: "Definitions and Tolerances for Artificial Daylight for Color Matching," *Journal of the Optical Society of America*, 29, 145 (Abstract) (1939).

SHOW WINDOW lighting in the Bachman Store, Southdale Shopping Center, Minneapolis, is applied in a decorative fashion, with the fixtures having an appearance of floating. Units are parabolic reflectors — white baked enamel on the inside and brushed aluminum exteriors, using 150-watt A23 lamps. Perforations in the sides of the reflectors provide sparkle, with the majority of lighting thrown on the fernery and the stone wall background.

Architect for the store is Schifflet Backstrom and Associates, electrical engineer is Lang and Cummings, all of Minneapolis. Photo and data courtesy of Louis J. Riegert, of B M D and R., also in Minneapolis.

INSTALLATION AT MOLONEY ELECTRIC CO., ST. LOUIS, MO.

High Bay Industrial Lighting

LIGHTING OBJECTIVE: To provide general illumination in a high bay area in which large transformers are fabricated.

GENERAL INFORMATION: The area shown measures 80 feet by 480 feet with a ceiling height of 68 feet. The bottoms of the roof trusses are 60 feet above the white concrete (50% RF) floor. All major room surfaces other than the floor are painted light green — the ceiling has a 30% reflectance; the columns and end walls have a 55% reflectance.

INSTALLATION: Ninety-six Benjamin catalog No. 3480 porcelain enamel reflector high bay luminaires are mounted 60 feet above the floor (to clear the top of the crane housing) and are spaced on 20-foot centers. Half of these luminaires (alternately spaced) are equipped with 1500-watt PS-52 incandescent filament lamps. The other half are equipped with H1000-C15 color improved mercury vapor lamps operated from Jefferson catalog No. 232-103 transformers.

There are four Benjamin elliptical angle reflector units, catalog No. 5538, each equipped with a 1000-watt PS-52 incandescent filament lamp, mounted 60 feet high on both end walls.

The initial average level of illumination was 55 footcandles. Brightnesses were as follows:

luminaires			
mercury vapor at 45°	410 ft-L	columns	20 ft-L
incandescent filament at 45°	340 ft-L	end walls	20 ft-L
ceiling	2 ft-L	floor	25 ft-L

Lighting designed by Roger W. Renkel, Lighting Specialist, Union Electric Co., St. Louis, Mo.; General Contractor: Wm. H. and Nelson Cunliff, 3320 Lindell, St. Louis, Mo.; Electrical Contractor: Gamp Electric Co., 2924 Locust, St. Louis, Mo.; Architect: Fred S. McNiell, 3920 Lindell, St. Louis, Mo.

Lighting data submitted by Roger W. Renkel, Lighting Specialist, Union Electric Co., 315 N. Twelfth Blvd., St. Louis 1, Mo., as an illustration of good lighting practice and to aid in the design of similar installations.

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A.I.A. File No. 31

Design and Characteristics of Fluorescent Lamps Having a Non-Circular Cross Section

(Discussion of a paper by J. O. Aicher and E. Lemmers published in November ILLUMINATING ENGINEERING)

JOHN F. WAYMOUTH:* The authors are to be commended for their interesting re-capitulation of the desirability of increasing the electron temperature in a fluorescent lamp if high efficiency is to be maintained at high power input,[1] as well as for their description of a geometrical means for achieving this goal. I would like to comment on one or two statements which I believe to be misleading and then to point out a few disadvantages of the u-shaped cross-section they have adopted.

I think Fig. 1 is misleading, and the subsequent derivation of $P^2/A^{3/4}$ as a factor of merit is incorrect. Fig. 1 applies only to bulbs of 18-inch arc length. The electrode wattage in the case of the 18-inch T12 amounts to approximately 30 per cent of the total, while for the 18T4, it amounts to less than 10 per cent of the total. Lowry, Gungle and Jerome[2] have shown that when comparisons are made on the basis of positive column efficiency alone that the T-12 is the most efficient, followed by the T-8 and then the T-4.

The fact that the T-4 in Fig. 1 has at 12 watts the same efficiency as the T-12 at 21 watts although it has only one-ninth the cross-sectional area is seen to be purely an end effect. Because of the smaller diameter, the positive column voltage drop is greater in the T-4, and hence the electrode drop is a smaller fraction of the total. Therefore, even though the positive column efficiency of the T-4 is less than that of the T-12, the 18-inch lamp has the same efficiency because of the reduced fraction of the input power consumed by the electrodes.

The figure of merit $P^2/A^{3/4}$ is therefore correct as it stands, but it applies only to 18-inch lamps. In 96-inch lamps the T-12 would be more efficient at any power input. Therefore, there must be a length factor incorporated into the figure of merit which has been presented, if it is to apply to all length of lamps.

The fact that krypton and xenon do not result in increased efficiency at the high wattage levels, I do not find to be in the least surprising in view of the lowered electron temperature obtained when these fill gases are used.[1] Their use would defeat the sole purpose of the u-shaped cross-section, if I understand the paper correctly.

The authors have re-emphasized the necessity of maintaining the correct mercury pressure in fluorescent lamps as well as the fundamental reasons therefore.[1,3,4] Presumably the vapor pressure in this lamp is optimum for operation at a power level of 25 watts per foot. The authors have also discussed operation at 50 watts per foot; under these conditions, a considerably higher vapor pressure would result. It would be necessary to change the envelope design to restore optimum vapor pressure, since the cool zones are the "rails" and "bridges." The alternative to this very costly procedure would be the use of cool end chambers as are used in the VHO lamps.

In connection with mercury vapor pressure control, the authors have made the statement that "it is especially important for cool areas to be present near the center of the lamp where mercury prefers to collect for reasons other than temperature difference, as a result of electrophoresis effects."

We believe this statement to be erroneous from our experience in VHO lamps which utilize cool zones at both ends of the lamp. We have made numerous measurements of the degree of uniformity of mercury vapor pressure in lamps of all lengths, with cool zones at one or both ends, by the very simple expedient of measuring the uniformity of light output from end to end. The only case in which any detectable difference is observed is when one cathode has failed and the lamp is rectifying; then the usual d-c pumping effect is observed. In normally operating lamps up to 8 feet with all the mercury in one end, no variation in mercury pressure is observed once the lamp has stabilized.

In the second place, the mercury vapor pressure in the lamp cannot exceed that determined by the temperature of the coolest spot, once equilibrium has been established and the lamp has been stabilized. If excess mercury evaporates in the center, it distills to the end and condenses. On our life test racks for VHO lamps we find that owing to different ambient conditions, one end of the lamps may run one or two degrees cooler than the other. When lamps are placed on the rocks after initial stabilization and readings, the mercury is usually equally divided between the cool zones at either end. After overnight burning, all the mercury has distilled to the coolest end, and the mercury pressure throughout the lamp continues to be that determined by the temperature of the cooler end.

The authors have described in some detail the advantages of the u-shaped cross section for their high-powered fluorescent lamps. There are one or two disadvantages, however, which they have not mentioned which are worthy of note. I will not dwell on the extremely bulky nature of the lamp, nor its excessive weight because these are obvious to all, but rather will address my attention to the non-uniformity of the light production.

Fig. A shows contours of equal current density in the u-shaped cross-section. The dashed lines show the region within which about 90 per cent of the current flows, and 90 per cent of the u-v is produced. The sectors A and B of the phosphor surface therefore, receive about 90 per cent of the u-v and produce 90 per cent of the light. Since these together comprise only about 50 per cent or less of the available surface area, the surface brightness of these areas is quite high. (Our measurements indicate brightness of the order of 8000-9000 footlamberts for these zones.)

Wholly aside from the aesthetic disadvantages of such highly non-uniform light emission and the difficulties in shielding that result, this has the very serious practical dis-

*Sylvania Electric Products, Inc., Salem, Mass.

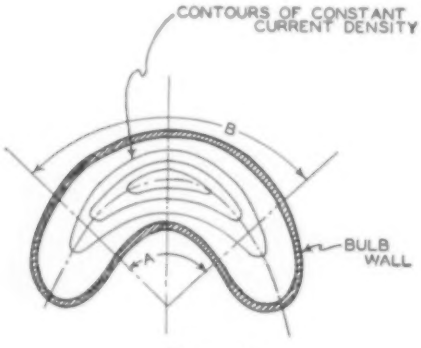

Figure A.

advantage of loading the phosphor that is giving the light to a much greater degree than in the VHO/25 lamps, for instance, where surface brightnesses are of the order of 6000 footlamberts. Lowry[5] in 1949, pointed out that lumen maintenance is related to phosphor loading. Though we have learned a great deal about lumen maintenance since 1949, it is still true, in general, that the heavier the loading, the poorer the maintenance. The problem is further compounded by the fact that in the u-shaped cross section, these light-producing zones also are the regions of highest temperature. We believe that the localized high phosphor loading and high temperature is a fundamental weakness of the design which will result in a serious lumen maintenance problem in power groove lamps.

1. Waymouth, J. F., Bitter, F., and Lowry, E. F.: "Factors to be Considered in the Design of High Output Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. LII, 257 (1957).
2. Lowry, E. F., Gungle, W. C., and Jerome, C. W.: "Some Problems Involved in the Design of Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLIX, 545 (1955).
3. Gungle, W. C., Waymouth, J. F., and Homer, H. H.: "Operating Parameters of High Output Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. LII, 262 (1957).
4. Waymouth, J. F., and Bitter, F.: "Analysis of the Plasma of Fluorescent Lamps," *Journ. Appl. Phys.*, Vol. 27, 122 (1956).
5. Lowry, E. F.: "Long Term Deterioration in Certain Phosphors Exposed to the Low Pressure Mercury Arc," *Journ. Electrochem. Soc.*, Vol. 95, 242 (1949).

W. C. ANDERSON:* One observation that should be made is the clarity with which the data have been set forth by Messrs. Aicher and Lemmers. They have described certain principles that influence the performance of fluorescent lamps, and particularly how these in combination influenced the design of the power groove lamp.

The understanding of the problems of lamp design and development that this paper affords is of interest to all who are concerned with fluorescent lighting. Interesting as this is to me, as a ballast designer, I am forced to a greater interest in the result of the development — the lamp itself.

Once a new lamp is available, a ballast must be designed to insure the operation of the lamp as the lamp designer intended. This in itself is no small task, but the problem does not exist "in itself." The complexities introduced by the applications, the uses to which the lamp will be put, in large part determine the direction the ballast designer will take.

When the power groove lamps were announced in June 1956, there was much discussion of the problem of heat dissipation. Higher lamp loading, larger ballasts, the effect of heat radiated by the lamps, all foretold a condition that warranted caution in the application of these lamps.

There was serious doubt expressed by some whether the ballast could remain an integral part of the fixture. Others, slightly less pessimistic, insisted that radical departures in fixture design would have to be made if these lamps were to be a practical lighting tool. The most optimistic were those who felt that while these problems would be solved, it would be a long time indeed before power groove lamps would be in actual use.

To the everlasting credit of the fluorescent lighting industry, the progress to date, practically in less than a year, has exceeded the estimates of the most optimistic.

Ballasts are available, and fixtures incorporating these ballasts and lamps are being marketed and installed. Caution has wisely been observed, but it has not seriously impeded progress. In fact, I am certain that the progress, if slower than the enthusiast would have wanted, is sure-footed, and this anticipates a steadily growing application.

Surely not all the problems are resolved to everyone's satisfaction. For one thing, more effective, and perhaps less costly ways to beat the heat problem are to be expected. But we are on our way — that is important.

*Jefferson Electric Co., Bellwood, Ill.

J. O. AICHER and E. LEMMERS:* In regard to Dr. Waymouth's criticism of our use of 18-inch lamps in our first illustration, I am sure that we pointed out that this was only the start of work leading to the concept of non-circular bulb geometry. Even though this expression is noted in the paper and mentioned in our presentation as being empirically derived, if we stretch it even to apply to 48-inch lamps as shown in our Fig. 3, we will see that it is surprisingly close to reasonable agreement with the results obtained.

We believe Dr. Waymouth has missed the point in basing all of his comments on round tubes. If two lamps having the same length and cross-sectional area, filled with the same filling gas at equal pressures, are compared at equal wattage, that lamp having the highest voltage will be the most efficient even if they are 96 inches in length. This is because such increase in voltage reduces both absolute and relative values of electrode losses.

Such a difference in lamp voltage under these conditions can be achieved only with other than round tubes.

We have stated that the concept of $P^2/A^{3/4}$ is not to be taken as a precise relationship. The greater prominence of tube perimeter (*i.e.*, wall area) is directly responsible for the increased lamp voltage which is desirable and for increased electron temperature which is highly desirable in increasing efficiency of ultraviolet production.

We feel that for wattages as high as 50 watts per foot, it would not be unreasonable to consider changes in shape of the bulb for maintaining optimum mercury vapor pressure control.

We have repeatedly observed, under certain conditions of no possible d c component, and using the technique that Dr. Waymouth mentions, of brightness distribution along the lamp's length, that mercury prefers to go not toward the lamp electrodes. Others in our laboratory have encountered the same phenomenon.

We feel that the non-uniformity of light distribution is not undesirable. However, we would like to refer this item to our Application Engineering group for discussion.

Dr. Waymouth has questioned lumen maintenance. In the present power groove lamp, which, it will be recalled, we said is only a start in the application of the principles of non-circular cross-section, we have met or exceeded the previously estimated figures at 3000 hours, in 48-inch lamps made on high production equipment.

Mr. Anderson's remarks comprise a very appropriate analysis of the situation in regard to the early utilization of non-circular cross-section lamps. We agree with his comments. His discussion seems to represent the attitude many have had toward a radically new product. That is, problems are recognized but their solution is looked forward to with confidence and optimism, while benefits are being utilized.

The discussion on this paper is similar to that on a paper presented in 1952 at Chicago on "rapid start."[1] There too, we had discussion where some gave major emphasis to the advantages of the new lighting tool and relegated the problems to a minor role, while others could see only problems.

We all know that in a few years the "rapid start" became a major portion of the new lighting business. I am confident that we will find non-circular cross-section lamps repeating the pattern.

1. Lemmers, A. E., and Brooks, W. W.: "New Fluorescent Lamp and Ballast Design for Rapid Starting." ILLUMINATING ENGINEERING, Vol. XLVII, p. 589 (November 1952).

*Authors, Large Lamp Department, General Electric Co., Nela Park, Cleveland, Ohio.

Views and Opinions

Ballast Heating in Fixtures

TWO FACTS face us in the fluorescent lighting industry, both important. (1) The problem of ballast heating in fixtures is real and present. (2) No problem can fail to respond to an honest attempt to examine the facts and to understand their meaning.

This discussion will review the facts, as I know them, through the eyes of a ballast manufacturer. We will solve no problem here — but we may be inspired to apply ourselves further, to a solution. To start at the beginning:

Less than twenty years ago, there was no fluorescent lighting. Today we could not imagine illumination without this common everyday tool. It's remarkable to realize that most of us not only watched the development of an entire industry from its birth to a modern giant, in eighteen short years. In fact, we were and are a factor in that growth.

The ballast industry was created out of whole cloth. Remember the first auxiliaries? And how they grew with another and another and still one more choke added in series with the lamps. As new lamp ratings were announced, new auxiliaries were added. We had one unit for a 40-watt lamp that I swear was longer than the lamp itself. A "Slim John" I think we called it.

Can you ever forget the built-in thermal starter element? We cannot. We know exactly how many we put into the field from our production and shipping records. We had an excellent cross check from our field return reports. Within months almost all were back in our possession, and in a couple of years, all were accounted for except one. Strange as it may be, this last one came back with its starter shorted just two months ago, proving that however poor the design, you can't help making a few good units.

These first faltering steps were destined along a path we now know was studded with glowing guide posts: the lead-lag circuit with power factor correction to win the utilities to the new lighting system, the slimline lamps out of cold cathode by higher voltage, the rapid start principle, the high output lamps and higher output and higher upward and onward.

The early days of the fluorescent ballast seem, in retrospect, to be much better than they probably were in actuality. I suppose that this is true of most things. Distance in time lends an aura of well-being over a job well done. What problems we had then were solved, and in the record book stand as accomplishments. We tend to forget the urgency that dictated our efforts, the pressure we responded to, the target dates we set, strove for, missed, reset, and finally hit.

One who would resurrect the past, and fairly evaluate the times would undoubtedly discern a strikingly accurate parallel to the present time. There is, however, one difference. That difference is the measure of the complex that we know today as the fluorescent lighting field.

In the early time, we were all neophytes — we all had much to learn. By all, I mean not only the ballast people but the lamp men, the fixture designer, the Underwriters' Laboratories, the lighting engineer, the architect, the user of light — all were playing a game for which rules had not yet been established. The industry set the rules, we lived by them, altering and refining as we progressed. From experience we learned. We listened to her teachings. We listened and learned together. We grew up together, knowing each other's problems, aiding one another as we could.

And we grew wise together. We knew so well the mutual objectives we sought, that each segment, independently, could pursue the goal. Such concentration of effort has seldom been witnessed. And the results, viewed independently, can hardly be surpassed.

The architect is able to get one more floor in every 10 or 12 because of reduced ceiling heights. Wonderful!

The lighting engineer can deliver more and more lumens to the seeing task because of higher output lamps. Wonderful!

The fixture designer contributes and shares in this achievement by getting his light source as close to the ceiling as he can.

The ballast designer also makes his contribution — shallower, narrower ballasts. Cross sections that were undreamed of are now the industry standards.

Each of these, standing alone as individual achievements, quite properly can be considered worthy. In fact, they can, and should be looked on with pride.

Consider the ballast of the present day. It is ingeniously designed within the limitations imposed by the specifying agencies. It is carefully engineered to hold cost and price to minimum values

without sacrifice of quality. It is manufactured with precise understanding of the elements of manufacture that can affect its ultimate performance. Watchful eyes of supervisor, tester, inspector, control the quality within the limits of the ballast capabilities. And it is a job well done. No one need apologize for the result.

If I can say this for the ballast as a ballast manufacturer, I am sure the other segments of the fluorescent lighting industry have spokesmen who can make similar statements concerning their particular product or contribution.

The entire industry should be enjoying the fruits of its labors. Instead we are plagued with a problem of epidemic proportions. Heat has become a word that typifies fluorescent lighting in the minds of countless of our customers. Hot ballasts, hot lamps, hot fixtures, hot tempers and sometimes hot arguments. All are commonplace to those of us who make our living in the fluorescent lighting industry today.

What has happened to us? What profits can there be when each individual accomplishment rates the stamp of excellence, if taken together the result falls short of bare adequacy? More important, to what end are we being carried by our separate enthusiasms

It would seem unnecessary to trace the pattern that has brought about the conditions so prevalent in present day installations. But for the sake of the record, the pattern should be reviewed:

(1) With lower ceiling heights, fixtures have become shallower.
(2) Rooms have become smaller in volume.
(3) Sound absorbent materials form the ceilings.
(4) Fixtures are mounted directly to these heat insulating materials.
(5) Ballasts have shrunk in cross section to fit into the scheme of things, resulting in less radiating surface for dissipating the heat due to inherent ballast losses.
(6) Lamps are covered with a diffusing plastic or glass.
(7) For a given raceway, the fixtures have employed more lamps, often higher rated lamps, to provide more light.

This is the pattern. Let's look at just one of the results. The four-lamp 40-watt rapid start totally enclosed surface-mounted fixture, I think you can all agree is a popular item in lighting today.

We have tested several of these lamps, of different manufacture, with various ballasts. I won't tell you the results of our tests on ballast case temperatures. It isn't necessary when you hear what I will tell you.

These fixtures were surface-mounted singly to an acoustical tile ceiling in an air conditioned room. The room ambient, measured one foot from the fixture, was maintained at 26C. The line voltage was maintained at 118 volts. Before we attempted to record operating ballast temperatures, we read the case temperatures on the ballasts mounted in place in the fixture while the lamps were powered from a ballast externally mounted on our test bench. The "cold ballast temperature" or what we called the "equivalent ambient" of the fixture was 74C.

I believe you are all aware that ballasts are designed to have a maximum case rise of 50C over a 40-degree ambient. The 90C maximum case temperature derives from this. I assure you that every ballast we tested in that fixture was acceptable within the test requirements to which the ballast designer is held. I further assure you that not a single ballast operated below a case temperature of 90C. None of them could surmount the 34C handicap placed on them by the fixture. And what of the capacitor? This device must not operate with a case temperature in excess of 70C. It takes no great mathematical prowess to determine the probability of this requirement being met. Before the ballast was energized, the capacitor was 4C over the limit.

Was this an extreme case? I doubt it. We found equivalent ambients to be lower in other four-lamp fixtures, but still greatly in excess of 40C. Then, too, remember that this was a single fixture, in an air-conditioned room at 26C, at 118 volts. Put these fixtures in the field where they are mounted in rows, sometimes in pairs with line voltages closer to 125 volts, and with room temperatures at least occasionally higher than 26C. Gentlemen, we do have a problem.

I propose that we must take a good hard look at the roads we have separately travelled to arrive at a destination none of us were headed for. We must travel together. Fixture man and ballast man cannot go separate ways. Architects and lighting engineers cannot exist in a cloistered atmosphere of theoretical success when their clients are forced to live with a practical failure.

Let us take advantage of the not insignificant knowledge that each segment of our Industry possesses. But let us pool that knowledge. We can set intelligent goals, and we can find intelligent solutions to the obstacles along the way, if we are willing to work together. That is what we did in the past. That is what we must do from this point on if we are to live up to the promise that fluorescent lighting holds out to us for the future. — W. C. Anderson, *Jefferson Electric Co., Bellwood, Ill. Substance of a talk before the Cleveland Section of IES, November 1957.*

LIGHTING NEWS

Research Symposium March 3 and 4 to Report New Finding on Illumination Levels and Glare

Four important research projects which are expected to greatly influence future recommendations of illumination levels and lighting practice in respect to disability and discomfort glare, are scheduled for completion sometime next month. Full details of these studies will be presented during a Research Symposium sponsored by the Illuminating Engineering Research Institute, to be held March 3 and 4 at the Dearborn Inn, Dearborn, Michigan.

Perhaps the most widely significant project is that dealing with quantity of illumination. This work has been under way some six years at the University of Michigan, under the direction of Dr. H. R. Blackwell, Director of the university's Vision Research Laboratories. For the past year it has become apparent from Dr. Blackwell's research findings that a completely new basis for the recommendation of illumination levels would emerge; publication of the third edition of the *IES Lighting Handbook*, then underway, was postponed pending completion of this research. Details of his findings will be presented at the Symposium by Dr. Blackwell.

Another newly completed research project to be presented at the Symposium will be results of studies of disability glare. Dr. Glenn Fry, Director of the School of Optometry, Ohio State University, will demonstrate a new portable meter to measure disability glare. It is expected that this meter will be largely useful for measuring glare in industrial lighting, street lighting, and floodlighting.

A new portable discomfort glare meter will be demonstrated by Dr. S. K. Guth of the General Electric Research Laboratories. The discomfort glare meter will evaluate the seeing comfort rating of interiors, and relative discomfort of roadway lighting systems.

Also on the program will be a presentation of results of research study of the loss of contrast due to specular reflections. This has been conducted, and will be presented at the Symposium, by Prof. Dan Finch, of the University of California.

Advance reservations for attendance at the Symposium should be sent directly to C. L. Crouch, Secretary of the Illuminating Engineering Research Institute, 1860 Broadway, New York 23, N .Y.

Council Meetings — 1958

Members of I.E.S. are invited to attend any meetings of the Council as guests, or to submit a communication for consideration on any matter, through their Regional Vice-President or the General Secretary. Meetings of Council are scheduled for the following dates in 1958.

February 13—New York, N. Y.
April 30 — Kansas City, Mo.
June 4-5 — New York, N. Y.

Maintenance Engineers Plan Conference in California

The Electrical Maintenance Engineers Association of Southern California has anounced plans for its Electrical Maintenance Conference to be held in connection with the 9th Biennial Electrical Industry show, scheduled for the Shrine Exposition Hall, Los Angeles, March 27 through 29, 1958.

Subjects on the conference program will include:

Small Industry Looks at Maintenance of Electrical Equipment — Chairman, Frank Tharp, Fluorescent and Floodlight Maintenance Co.
How to Estimate Additions and Expansions — Chairman, Charles H. Hays, The Electrical Estimators, Inc.
Know Your Electrical Codes and Safety Orders — Chairman, King Christopher, The Clark Controller Co.
Electronic Equipment Requires Maintenance — Chairman, K. Lee Alvey, Air Research Manufacturing Co.
Protective Devices Must Be Properly Selected and Maintained — Chairman, T. P. Regas, Bulldog Electric Products of Los Angeles.
High Power Factor Can Pay Big Dividends — Chairman, William H. Warren, Jr., Southern California Edison Co.
Large Industry Looks at Maintenance of Electrical Equipment — Chairman, Kenneth T. Shar, Westinghouse Electric Corp.
Proper Maintenance of Lighting Will Assure Peak Output — Urban Beh, Consulting Lighting Engineer.
Plan Maintenance to Prevent Breakdown — Chairman, W. E. Cline, General Electric Co.
Commercial Buildings Look at Maintenance of Electrical Equipment — Chairman, Edmund Lanski, ITE Circuit Breaker Co.

Paul H. Henrichs of Southern California Edison Co. is Chairman of the Conference Program.

Engineers Group Organized In New York State

A statewide consulting engineer's organization, known as the New York State Association of Consulting Engineers, Inc., has recently been formed and incorporated, with headquarters at 2507 James St., Syracuse, N. Y.

To date, the state association consists of the following chapters: Western New York, Central New York and Rochester. Officers elected to serve until July of 1958 are:

Howard F. Eckerlin, President and Director
James N. DeSerio, Vice-President and Director
Frank E. Kulas, Secretary-Treasurer and Director
Realto E. Cherne, Director
Paul Robson, Director
Donald Brill, Director.

Membership in the group is restricted to chapters whose members are consulting engineers in private practice.

Western New York Section Conducts Lighting Course

Fundamentals of Industrial Lighting Design was a series of six meetings, conducted in Buffalo during October and November, sponsored by the Western New York Section of I.E.S.

Registration for the six sessions was 70 with an average attendance of 52. Those attending included people from local industrial plants and from the offices of electrical contractors, wholesalers, architects and consulting engineers.

Ten Symposiums Planned for National Lighting Exposition

The National Lighting Exposition, being held at the New York Coliseum on March 9-12, will feature a series of ten special symposiums covering major categories of lighting techniques and installations, it was announced recently.

Designed to provide architects, contractors, engineers and builders with authoritative information on illumination, eight of the symposiums will cover these key areas of lighting installations: residential, office, merchandising, industrial, public recreation, street and highway, school, and public institutions (hospital, bank). Two additional symposiums will discuss new developments in light sources and improved techniques of light utilization. A special auditorium has been scheduled at the Coliseum to accommodate the symposiums, which will be held from 11 a.m. to 2 p.m. each day of the show.

Harold Meyer, president of the National Lighting Expositions, has said that pre-registration for the series, which will feature recognized authorities in each of the respective fields, is "already ahead of our expectations." He has said that 500,000 invitations are currently being sent to wholesalers, contractors, architects and builders by exhibitors and by the Lighting Lamps and Electrical Manufacturers Salesmen's Association, Inc., the sponsoring organization.

Among the broad categories represented by exhibits at the exposition will be lighting for the home, church, street, factory, theatre, highway, design, rural, laboratory, indoor display, animal husbandry, sign, refinery, school, plant, store, airport, office, hospital, institutional, ship, outdoor display, holiday, stage, mine, port and dock.

Applications for Retired Membership

New retired membership classifications became effective in the fiscal year beginning October 1956. Privileges in these new grades, earned by long membership in the Society, include reduced annual dues ($5.00) with continued receipt of all Society mailings including ILLUMINATING ENGINEERING. Such members will be designated as Member, Retired; Associate Member, Retired.

Those who are interested and qualified (at least thirty years of membership and 65 years of age) should write to the General Secretary at Society Headquarters, stating that they have retired from regular occupation in business or profession.

January 27-29, 1958 — American Society of Heating and Air-Conditioning Engineers, Incorporated, Annual Meeting, Pittsburgh, Pa.

January 28-31, 1958 — 14th Annual Technical Conference of the Society of Plastics Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

February 3-7, 1958 — American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York, N. Y.

February 9-15, 1958 — National Electrical Week.

February 13, 1958—Council Meeting, I.E.S., New York, N. Y. Members are free to attend meetings of Council as guests.

February 20-21, 1958 — 14th Annual National Wiring Promotion Conference, Statler Hotel, Detroit, Mich.

March 2-5, 1958 — National Electric Sign Association, National Convention, Shamrock Hilton Hotel, Houston, Texas.

March 9-12, 1958 — First National Lighting Exposition, New York Coliseum, New York, N. Y.

April 10-11, 1958 — Northeastern Regional Conference, Statler Hotel, Hartford, Conn.

April 14-15, 1958 — East Central Regional Conference, John Marshall Hotel, Richmond, Va.

April 20-26, 1958 — Society of Motion Picture and Television Engineers, Ambassador Hotel, Los Angeles, Calif.

April 24-25, 1958—South Central and Southeastern Regional Conference, Lafayette Hotel, Little Rock, Ark.

April 28-29, 1958 — Southwestern Regional Conference, Hotel Washington Youree, Shreveport, La.

April 30, 1958 — Council Meeting, I.E.S., Hotel President, Kansas City, Mo. Members are free to attend meetings of Council as guests.

May 1-2, 1958 — Midwestern Regional Conference, Hotel President, Kansas City, Mo.

May 8-9, 1958 — Inter-Mountain Regional Conference, Whitman Hotel, Pueblo, Colo.

May 12-13, 1958 — South Pacific Coast Regional Conference, El Cortez Hotel, San Diego, Calif.

May 22-24, 1958 — Pacific Northwest Regional Conference, Multnomah Hotel, Portland, Oregon.

June 4-5, 1958 — Council Meeting, I.E.S., New York, N. Y. Members are free to attend meetings of Council as guests.

June 8-12, 1958 — National Association of Electrical Distributors (50th Anniversary Convention), Civic Auditorium, San Francisco, Calif.

June 9-13, 1958 — National Association of Electrical Distributors, 50th Annual Convention, San Francisco, Calif.

June 23-24, 1958 — Great Lakes Regional Conference, Sheraton Hotel, Rochester, N. Y.

June 23-27, 1958 — American Institute of Electrical Engineers (Summer General Meeting), Buffalo, N. Y.

August 17-22, 1958 — Illuminating Engineering Society (National Technical Conference), Royal York Hotel, Toronto, Canada.

August 19-22, 1958 — American Institute of Electrical Engineers, Pacific General Meeting, Sacramento, Calif.

September 22-25, 1958 — Institute of Traffic Engineers (Annual Meeting), McAllister & Columbus Hotels, Miami, Florida.

October 8-10, 1958 — Canadian Electrical Manufacturers Association (14th Annual Meeting), Sheraton Brock Hotel, Niagara Falls, Canada.

October 13-15, 1958 — National Electronics Conference, Inc., Hotel Sherman, Chicago, Ill.

October 19-24, 1958 — Society of Motion Picture and Television Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

October 20-24, 1958 — National Safety Council (46th National Safety Congress & Exposition), Chicago, Ill.

October 27-31, 1958 — American Institute of Electrical Engineers (Fall General Meeting), Pittsburgh, Pa.

November 10-14, 1958 — National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

November 18-20, 1958 — American Standards Association (9th Annual Conference on Standards), Hotel Roosevelt, New York, N. Y.

I.E.S. National Technical Conferences

1958 — August 17-22 — Royal York Hotel, Toronto, Ontario

1959 — September 7-11 — Hotels Fairmont and Mark Hopkins, San Francisco, California

1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri

1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

Here and There with I.E.S. Members

Charter of the new Coastal Empire Chapter is accepted by Chapter Chairman Dallas L. McClellan, left, with Southeastern Regional Vice-President James A. Banton making the presentation. The ceremony took place on October 22. Mr. Banton also installed the officers for the coming year. The Chapter, which is the Society's 77th, has its headquarters in Savannah, Ga.

Many I.E.S. members are included in this group of utility engineers at a Lighting Conference at Wheeling, West Va., October 28-30. Conference theme: "Quality Lighting — Today and Tomorrow." Sessions were led by R. G. Slauer, Sales Manager, and G. W. Clark, Manager of Engineering of this fixture plant of Sylvania Electric Products Inc., which sponsored the meeting.

President's Luncheon of the Michigan Section, October 8, had an attendance of 150 to honor President K. M. Reid. Left to right at the head table are: internationally famous Mrs. Jean Hoxie, Tennis Director of the Hamtramck, Mich., School System; R. M. Taylor, Great Lakes Regional V-P; James Finn, Section Chairman; President Reid; Adriann Van Hoss, Program Chairman; and Lee Tayler, Past President of I.E.S.

Officers of four Sections and Chapters of the Southeastern Region met in Atlanta November 18 for a highly valuable local activities meeting, covering a 25-point agenda. Standing are: Alvin Phillips, Secretary, Palmetto; James A. Lowe, Vice-Chairman, Tar Heel; J. J. Cardo, Chairman, Tar Heel; T. L. Cordle, Secretary, Tar Heel; J. W. White, Chairman, Palmetto; R. L. Simmons, Chairman, Florida; S. J. Andre, Secretary, Georgia. Seated are Walter Fink, Chairman, Georgia; and members of the "faculty," J. B. Browder, Second Vice-President; J. B. Banton, Southeastern Regional V-P; J. D. Mitchell, Director; A. D. Hinckley, Executive Secretary of I.E.S. Present but not shown were Glenn Park, and behind the camera, Tom Haslam, Vice-Chairman, Georgia.

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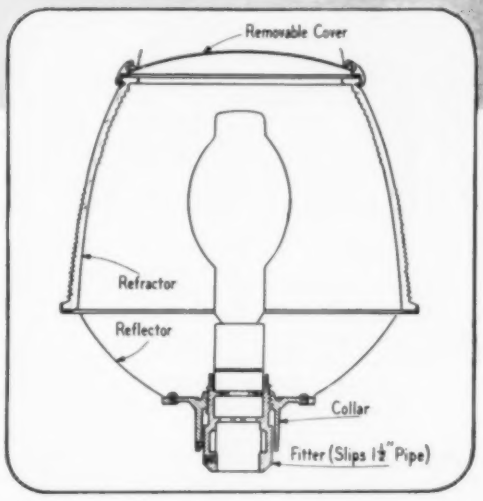

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- **Adjustable Light Distribution** . . . Entire unit can be rotated, up or down while lamp is on, to adjust beam of maximum candlepower. Set screw locks unit in adjustment.
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Architects, Michigan Section Hold Joint Meeting

A highly successful joint meeting was held November 19 by the Michigan Section of I.E.S. and the Detroit Chapter of the American Institute of Architects. It consisted of two sections: a Technical Study Forum and an evening session with four speakers.

Speaker at the Technical Study Forum was Stephen Squillace who discussed wiring. The Forum was conducted by Professor Edward L. Fairchild. Attendance was 110.

The evening meeting was conducted under the joint chairmanship of Frank North of the Michigan Section, I.E.S., and Lyall Askew of the Detroit Chapter of A.I.A. Speakers were William Capp and Fred Stickle of A.I.A., and I.E.S. members Eric Church and Will Fisher. A lively and interesting panel discussion followed their presentations on lighting and architecture. Attendance at this session was about 200.

Plans are underway by the two groups on the formation of study panels in the fields of office, school, industrial and commercial classifications.

EVENING session of the Michigan Section joint meeting featured four speakers. These are, l. to r., seated: Fred Stickle, A.I.A.; Eric Church, I.E.S.; William Capp, A.I.A. and Will Fisher, I.E.S. Officers of the two groups are, standing: Lyall Askew, Co-Chairman, A.I.A., Vice-President of the Detroit Chapter; James Finn, Chairman, Michigan Section of I.E.S.; Gerald Diehle, President of the Detroit A.I.A. Chapter; and Frank North, Co-Chairman of the A.I.A. Chapter and the I.E.S. representative to the fellow organization.

Membership Survey Results Reported to Council

Some of the very interesting statistics on the IES membership, emerging from the membership survey made last Fall, were reported to Council on December 12, by C. E. Ellis, staff Advertising and Promotion manager. Of particular interest were the data on business categories into which IES members are divided, numbers binding copies of the journal, fields of special interest and other pertinent information.

The survey was conducted, beginning last August, by John T. Fosdick Associates, well recognized national research organization. Response was 66.4 per cent of the total mailing, offering a reliable and representative cross section for membership analysis. All tabulations were performed on IBM punch cards, so that further study of various results may be made.

Tabulated results of first studies of the membership survey information have been included in a mailing piece, copies of which are available upon request to Mr. Ellis at IES headquarters office.

JOINT meeting of the Michigan Section with the Detroit Chapter of A.I.A. began with a Technical Study Forum.

Fellowships Available at Bureau of Highway Traffic

The Bureau of Highway Traffic of Yale University again announces the availability of fellowships for the graduate course in traffic engineering, to qualified graduate engineers who are citizens of the United States. The fellowships cover a full academic year, starting in September of 1958 and terminating the following May. They provide a living stipend of $1,400 disbursed at the rate of $175 per month for a period of eight months. They also provide the tuition of $600. These fellowships are made available to the Bureau through grants from the Automotive Safety Foundation, the Esso Safety Foundation, The Liberty Mutual Insurance Co. and the James S. Kemper Foundation.

Since the complexities of modern traffic require scientific treatment, cities and states increasingly seek the results of

(Continued on page 15A)

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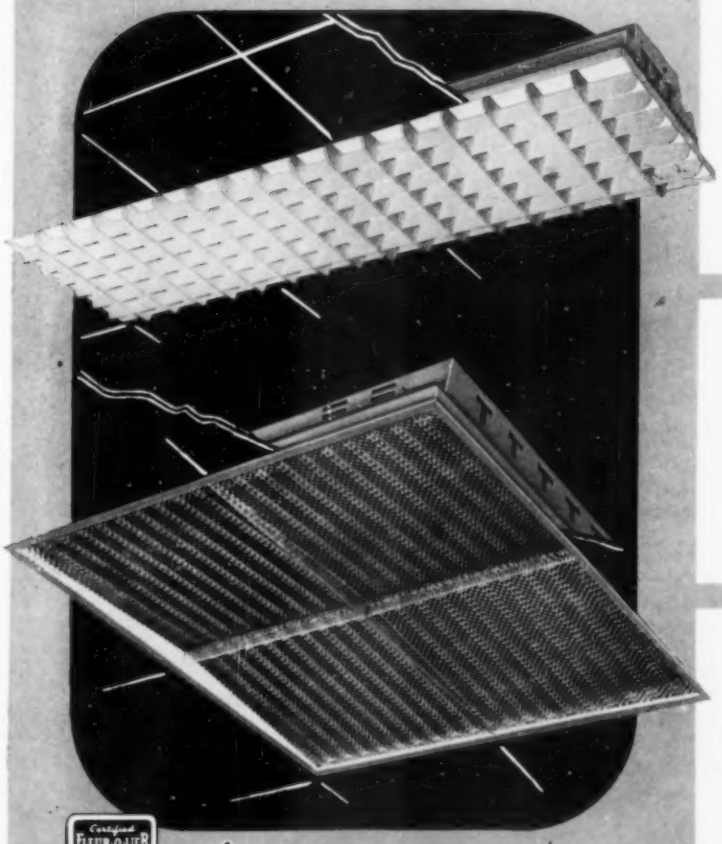

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T-Bar
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1 x 8
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2 x 4
4 x 4

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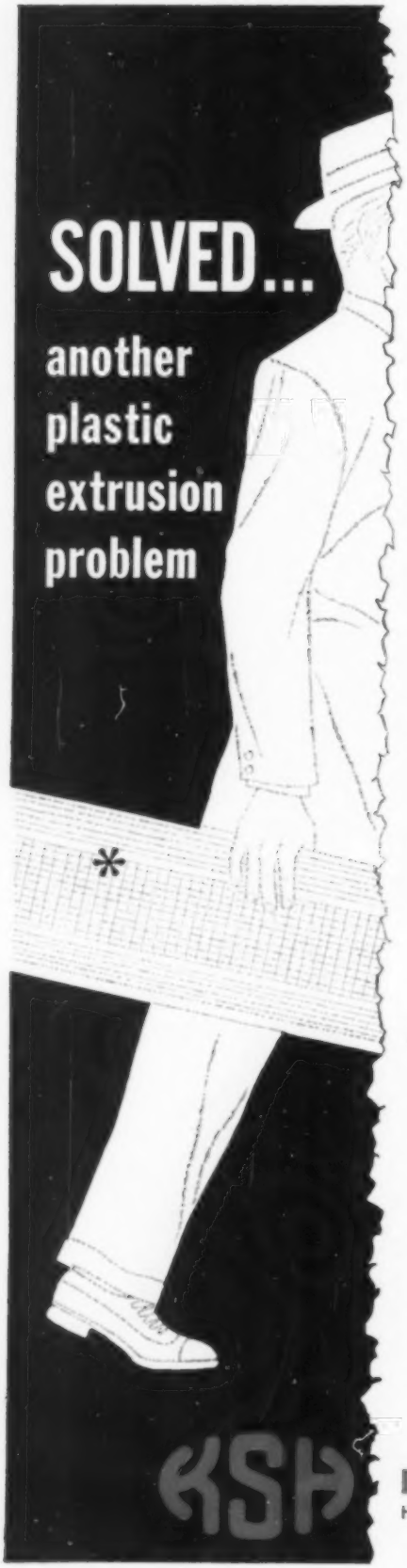

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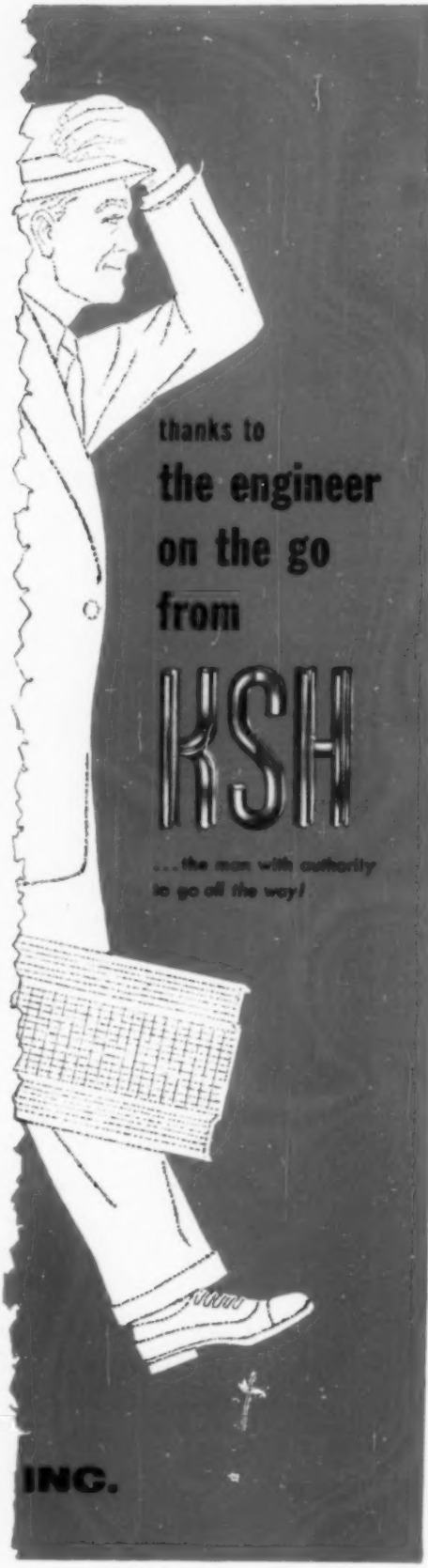

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(*Continued from page 12A*)

traffic research and the services of professional traffic engineers. The demand for traffic engineers already exceeds the rate of their graduation. In addition to the fellowships, the Bureau offers tuition scholarships to qualified municipal and state highway engineers who will receive salaries from their employers while undertaking the graduate work.

Applications for admission and fellowships may be obtained by writing to Mr. Fred W. Hurd, Director, Bureau of Highway Traffic, Yale University, Strathcona Hall, New Haven, Conn. Closing date for filing applications is March 1, 1958.

Ozark Study Club Holds Organizational Meeting

The December 4 organizational meeting of the Ozark Study Club of the St. Louis Section, I.E.S., attracted an attendance of 30 to the Kentwood Arms Hotel in Springfield, Mo. The dinner meting was presided over by the Club Chairman, Tom H. Condon.

Vice-President of the Midwestern Region, Joe Schneller was the first speaker, talking on general I.E.S. affairs and the operations of the Regions. St. Louis Section Chairman Dick Cohen gave the group a story on its relationship with the Section and how to arouse and maintain interest. E. W. Stohlmann, featured speaker, then presented his prize winning entry in the My Most Interesting Lighting Job Contest of several years ago — on re-lighting a court house.

Brooks Chassaing, Director of the Society, concluded with a discussion on what I.E.S. is and what it can accomplish.

OZARK Study Club at its December 4 meeting, at the Kenwood Arms Hotel, Springfield, Mo.

HEAD table at the Ozark Study Club meeting, left to right: R. D. Cohen, Chairman, St. Louis Section; Tom H. Condon, Chairman, Ozark Study Club; Brooks Chassaing, Director of I.E.S.; E. W. Stohlmann, Jr., featured speaker.

Fundamentals and Design Courses Offered in Philadelphia

Two courses, one on Fundamentals of Illumination and another on Illumination Design, are being sponsored by the Philadelphia Section of I.E.S. in cooperation with the Spring Garden Institute.

The Fundamentals course, ten 2¼-hour classes, is open to anyone wishing basic training in lighting. Topics covered are:

January 7 — Light and Sight — Carl J. Billig, Pennsylvania State College of Optometry; and A. S. Turner, General Electric Co.
January 14 — Light Standards, Control and Measurements — C. W. Rudolph, Philadelphia Electric Co.
January 21 — Light Sources: Part I, Fluorescent — P. R. Holmes, General Electric Co.
January 28 — Light Sources: Part II, Incandescent and Mercury — R. R. Enghouser, Sylvania Electric Products Inc.
February 4 — Lighting Calculations — G. T. Anderson, Philadelphia Electric Co.
February 11 — Interior Lighting: Schools, Offices and Public Buildings — L. Winters, Pittsburgh Reflector Co.
February 18 — Interior Lighting: Stores and Sign Lighting — G. T. Shoemaker, Philadelphia Electric Co.
February 25 — Interior Lighting: Industrial Lighting — M. N. Flynn, Benjamin Electric Mfg. Co.
March 4 — Exterior Lighting — M. N. Flynn, Benjamin Electric Mfg. Co.
March 11 — Lighting Economics — T. G. Broussard, Westinghouse Electric Corp.

The Illumination Design course is for those with experience in lighting. The material presented is of an advanced nature. This is as follows:

January 9 — New Developments in Light Sources, Luminaires and Auxiliaries — A. S. Turner, General Electric Co.; P. F. Kyack, P. F. Kyack Co.; W. Mitchell, General Electric Co.
January 16 — Architectural Aspects of Lighting — Vincent G. Kling, A.I.A.
January 23 — Wiring and Switching — A. B. Pentony, Harry F. Ortlip Co.
January 30 — Coordination in Design — J. McKinley, and H. B. Price, A. Ernest D'Ambly Engineers.
February 6 — Color in Lighting and Its Control: Black Light — P. F. Kyack, P. F. Kyack Co.; P. B. Thorne, General Electric Co.
February 13 — School and Office Lighting — Leon Clemmer, Office of Vincent G. Kling; Geo. Potts, A. Ernest D'Ambly Engineers.
February 20 — Store Lighting — P. F. Kyack, P. F. Kyack Co.
February 27 — Public Buildings — H. H. Swinburne, Nolen & Swinburne, Architects.
March 6 — Home Lighting — Miss E. A. Meehan, Philadelphia Electric Co.
March 13 — Industrial Lighting — M. N. Flynn, Benjamin Electric Mfg. Co.

Official text for the courses is the *I.E.S. Lighting Handbook*. Classes are held at the Spring Garden Institute. Tuition fee is $30 for each course.

(*Continued on page 16A*)

Aviation Lighting Committee Fall Technical Conference Papers Available

A limited number (15) of the valuable papers presented before the Aviation Committee's Fall Technical Conference will be available from IES headquarters, on a first-come-first-serve basis. Requests for copies of these papers (listed below) should be made to C. L. Crouch, Technical Director of IES.

The Conference, annually a most important gathering of aviation lighting people, was held October 22 and 23 at Wright Air Development Center, Dayton, Ohio. Following the opening address by W. T. Harding, Technical Director of the Aeronautical Accessories Laboratory, Wright Air Development Center, the 150 registrants at the Conference participated in discussion of numerous phases of aviation lighting. Included in their program, also, were demonstrations and movies of new aeronautical techniques, a dinner and field trip to the plant of Grimes Manufacturing Co., at Urbana, Ohio, and a tour of the environmental test facilities at the Aeronautical Accessories Laboratory. Papers presented, copies of which are available, included:

Aircraft Lighting Systems and Trends

(1) Modern Aircraft Lighting, by R. K. Davis, Ass't. Chief, Lighting Section, Aeronautical Accessories Laboratory. This paper outlines problems encountered in providing lighting for modern high speed aircraft. It also describes some of the means being used to solve these problems.

(2) Specialized Aircraft Lighting for Probe and Drogue Type Aerial Refueling, by W. A. Seadler, Group Engineer, Hayes Aircraft Corp. The presentation covers (a) a description of the refueling operation, (b) lighting requirements for different phases of the operation, (c) description of the lighting in use on the KB-50 Tanker and results of tests and (d) a description of receiver lighting.

(3) Anti-Collision Light for Jet Aircraft, by J. E. Shearer, Project Engineer, Boeing Airplane Co. This paper gives results of tests made by Boeing Airplane Company on a B-52 and discusses requirements for an anti-collision light from the manufacturer's point of view.

(4) Designing Aircraft Lighting Fixtures for Increased Ambient Temperatures, by F. C. Breckenridge and R. W. Crouch, National Bureau of Standards. The temperature limitations of present designs of exterior aircraft lighting equipment have been studied. These are reported together with suggestions for designing fixtures for use at increased ambient temperatures, with an indication of the limiting ambients at which such materials are satisfactory.

Aircraft Lighting Fixtures and Components

(1) Air Force Integral Instrument Lighting, by Lt. Peter Downey, Project Engineer, Support Equipment Section, Flight Control Laboratory. This paper discusses the present Air Force approach to and future development programs for instrument lighting. Among the integral lighting approaches which are discussed are the wedge, back lighting and electroluminescence.

(2) Recent Developments in Aircraft Lamps, by J. W. Tuttle and M. A. Mortensen, Miniature Lamp Dep't., General Electric Co. The paper summarizes some of the recent developments in aircraft lamps, particularly with respect to temperatures, vibration and space requirements.

(3) The Use of Reflex-Reflective Materials for Aircraft Identification at Night, by C. A. Baker, Chief, Visual Displays Section, Psychology Branch, Aero-Medical Laboratory. This paper discusses the advantages and disadvantages of using reflex-reflective materials for aircraft identification at night. The paper is concerned with problems of air to air identification and with flight line identification.

(4) Studies Pertaining to the Effects of Acceleration on Vision, by W. J. White, Biophysics Branch, Aero Medical Laboratory. The report brings together information which is pertinent to the effects of acceleration on human vision. The implication of these findings for aircraft lighting systems are pointed out. In presenting this information, the report attempts to outline problems which still demand research clarification.

Aircraft Environmental Requirements

(1) Present Trends in the Vibration Testing of Airborne Equipment, by D. C. Kennard, Jr., Chief, Dynamics Section, Engineering Support Branch, Aeronautical Accessories Laboratory. Some of the vibration characteristics of jet-powered aircraft are outlined. The relationship between jet noise and vibration is discussed briefly from the standpoint of the environment applying to airborne equipment. This leads to a reappraisal of the methods for stimulating service conditions of vibration in the laboratory.

(2) Recent Advances in Environmental Testing Technique, by C. W. Gerhardt, Chief, Atmospheric Deterioration Section, Engineering Support Branch, Aeronautical Accessories Laboratory. The paper includes a resumé of recent changes in (test) environments such as sunshine, salt fog, high and low temperature, altitude, explosion-proof testing, etc.

Airport Lighting

(1) Application of Radioisotope Activated Light Sources, by C. C. Carroll, Coordinator of Research, United States Radium Corp. The paper deals primarily with light sources utilizing Krypton 85 or H^3 gas, and sources in which the H^3 is also used as a tritide foil. It discusses various applications in the aircraft industry, including such things as drogue illumination, exit marking, safety lights of various types, ground equipment markers on which such units have either already been tested or where they appear to hold considerable promise as a substitute for electrically powered or battery operated means. The paper also covers some of the solid isotopes, pointing out their potential uses and limitations.

(3) Flush Runway Lights, by A. E. Wallis, Airfield Lighting Project Engineer, Lighting Section, Aeronautical Accessories Laboratory. The paper discusses the development history of flush lights and their present status. The results of the dynamic tests of flush lights at NACA, Langley Laboratory are also presented.

(4) Flight Test Data of the CAA Runway Lighting Evaluation Program, by R. F. Gates, Flight Operations Specialist, Civil Aeronautics Administration. Covers the evaluation program which was conducted at Andrews Air Force Base and outlines the plans the CAA has made for continuing the study of the low visibility lighting problem.

(5) Some Problems in Approach Lighting, by C. A. Douglas, Physicist, National Bureau of Standards. Four problems in the development of approach-lighting systems — glare control, elevation guidance, test methods and standardization are analyzed. The effect of these problems on the design of approach-light systems is discussed and suggestions for the solution of some of them are included.

IES Aviation Lighting Committee Reports Activities at Press Meeting

Editors of several magazines and newspapers gathered at IES Headquarters on November 20, for a press conference with leading members of the IES Aviation Lighting Committee. Significant findings reported at the committee's semi-annual review of new aviation lighting tech-

(*Continued on page* 18A)

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Color — controlled to fit the mood

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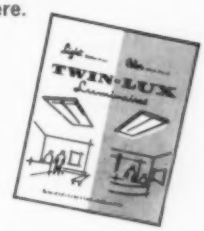

niques, held during October at Wright Air Development Center, Dayton, Ohio, were outlined for the press. Studies undertaken by the IES committee were demonstrated, including problems of lighting under fog conditions, flashing versus stable lights, fixed lights for orienting direction, etc. Anti-collision lights, and CAA provisions for anti-collision beacons also came under study by the IES committee.

Considerable interest was shown by the press in the work of the Aviation Lighting Committee, which undertakes studies of the principles of lighting as related to the problems of aviation. Working with them in developing suitable equipment and techniques are SAE and NEMA committees, in a joint effort which has in many areas been greatly fruitful.

Participating in the conference were Lester C. Simpson, Chairman of the IES Aviation Lighting Committee, Martin A. Warskow, Port of New York Authority, Thomas Edwards, and R. J. Stefany, committee secretary, and C. L. Crouch.

Mixed Red, White Light Makes All Other Colors

(The following news item is reprinted, with permission, from the New York Herald Tribune, *where it appeared under the by-line of Robert C. Toth on November 21.)*

The National Academy of Sciences yesterday saw a full-color picture of a green-sweatered blonde thrown upon a screen. Members immediately termed the picture "remarkable" — because the colors had been created from red and white light only.

The picture was part of a dramatic demonstration of color vision that could not be explained with accepted theories of light.

Dr. Detley W. Bronk, academy president who arranged for a special second showing of the experiments at the academy meeting, said: "I find it difficult to believe what I saw." Dr. Isidor I. Rabi, Nobel Prize winner and chairman of President Eisenhower's Scientific Advisory Board, said he had no explanation for the phenomenon.

Dr. Edwin H. Land, author of the experiments, refused to speculate on possible explanations of the phenomenon in terms of light theory. As for sight, he suggested that "there is not a tight identification between the wavelength of the stimulating light and the sensation of hue (or color).

Instead the red light may stimulate the eye, but the sensation of color is given across the entire range of the spectrum, he said.

No estimate of the impact of the finding was offered by scientists, but intense study of the report is expected.

More than 100 scientists, attending the concluding session of the three-day meeting at Rockefeller Institute, witnessed the unique mixing of red and white light. The entire range of colors was produced from blue and yellow to green, in addition to the expected pink shades.

Dr. Land said of the results: "If you follow conventional theories, you cannot explain (the colors). In some ways they are in specific conflict" with current explanations of light and how we see color.

Dr. Land is president and research director of the Polaroid Corp., which manufactures the self-developing cameras. He credited two early experimenters with studying the same phenomenon in 1914, although their findings were never recorded.

White light is composed of all the colors of the spectrum, including red, orange, yellow, green, indigo, blue and violet. It has been held that the eye responds to the three primary colors, red, green and blue, from which all shades are made.

Dr. Land's demonstrations indicated that only red and white light may be needed as the primary stimuli for color vision, rather than the three colors.

To create the phenomenon, Dr. Land took two black-and-white pictures simultaneously, one through a red filter and the other through a green filter which admitted only green light.

These pictures were superimposed onto a screen, the red-filtered shot projected in red light, the green-filtered picture in white light. The result was a faithful reproduction of the original colors in the subject matter.

In another experiment, two identical charts of gradually deepening gray areas were projected onto the screen, one in red light, the other in white. Only the expected hues of pink were created. None of the greens and blues was present.

An Important Message to All Members of I.E.S.

Membership in the Illuminating Engineering Society can be compared to an electric motor — you can only get out of it in relation to what you put into it.

Previously we have discussed just a few of the many advantages that come through your membership. But now we want to emphasize a point that may be overlooked in our everyday busy life — *participation*. It is true that if you received no more from your membership than the monthly issues of ILLUMINATING ENGINEERING your membership in I.E.S. will be well re-paid, and it is equally true that if you thoroughly read and study the many authoritative papers and articles appearing in our journal, your own knowledge of the science and art of illumination is enhanced.

But why short-change yourself — and, by the way, short-change your Society a little bit too?

Attend each and every meeting of your own Section or Chapter — but more than merely as a spectator. Join actively in the affairs of your Section or Chapter, take an active part in the discussions that occur at these meetings, feel free to stand up and express your opinions, become a member of one of the many important Committees within your Section or Chapter.

Every member of our Society has something to offer his fellow members, and it follows that you may learn something of value from what others have to say.

At most Section and Chapter meetings the featured speaker is a person of recognized authority in his chosen field of illumination, but only by hearing him can you receive the factual message presented. And we urge you to go one step further, bring a guest with you, so that the authoritative knowledge on illumination can be shared by many instead of just a few.

NATIONAL MEMBERSHIP COMMITTEE, I.E.S.

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Now a transformer that is 20% lighter than before, making it easier to handle, install, and transport

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A 25% reduction in size—three inches shorter—makes it easier to mount, especially in pole-bases

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Now you get regulation as close as ±1% even when line voltage fluctuations are as great as ±13%

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An outstanding efficiency of 89.2% insures less consumption of current and lowers lamp operating costs

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actual size

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20% less weight than before. With a reduction in weight of from 42 to 34 pounds, handling during shipping and installation is easier. Lower weight also results in less load on lighting poles when the transformers are mounted aerially.

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You get lamp wattage regulation as close as ±1% even with line voltage fluctuations as great as ±13%. The line current never exceeds normal operating current under any conditions. The primary voltage must drop 30% from nominal before the lamp extinguishes.

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A Sola-engineered new circuit design gives an improved efficiency rating of 89.2% with only a 50-watt loss through the transformer. This lower loss means less total wattage consumption and less operating cost for the mercury lighting system operation.

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The housing has a unique hydraulic-pressed mechanical closure which is completely solder-sealed. Special neoprene-coated leads are brought out through a neoprene gasket in the threaded nipple. This makes the transformer absolutely weatherproof and watertight.

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Lamp	1, H-1, 400-watt mercury lamp
Primary Volts	100-130 x 200-260 volts, 60 cycles
Primary Current	4/2 amps
Open Circuit	330 volts
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Power Factor	90% min. over entire range
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Colonial Premier Co.
466 W. Superior St.
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(Continued on page 24A)

Name of official representative given in italics.

The Blauvelt School Story...

This forward-looking school recently added 13 new *color-engineered* classrooms—each illuminated with the new *eye-rest green* version of Sylvania's sensational Scott lighting fixture.

Sylvania Eye-Rest Green Scott Fixture makes

Principal Leo Poulos (l.) and School Board President H. L. Niederauer compare the Scott with 3-year-old lighting . . . find the Scott's footcandle levels far greater—and brightness contrasts at a minimum.

THE magic of *color engineering* has gone to work in the modern Blauvelt, N. Y., School. Colorful new classrooms help motivate students to enjoy their schoolwork. Sylvania's Scott fixture, with translucent eye-rest green louvers, enhances the various color schemes with the latest in classroom lighting.

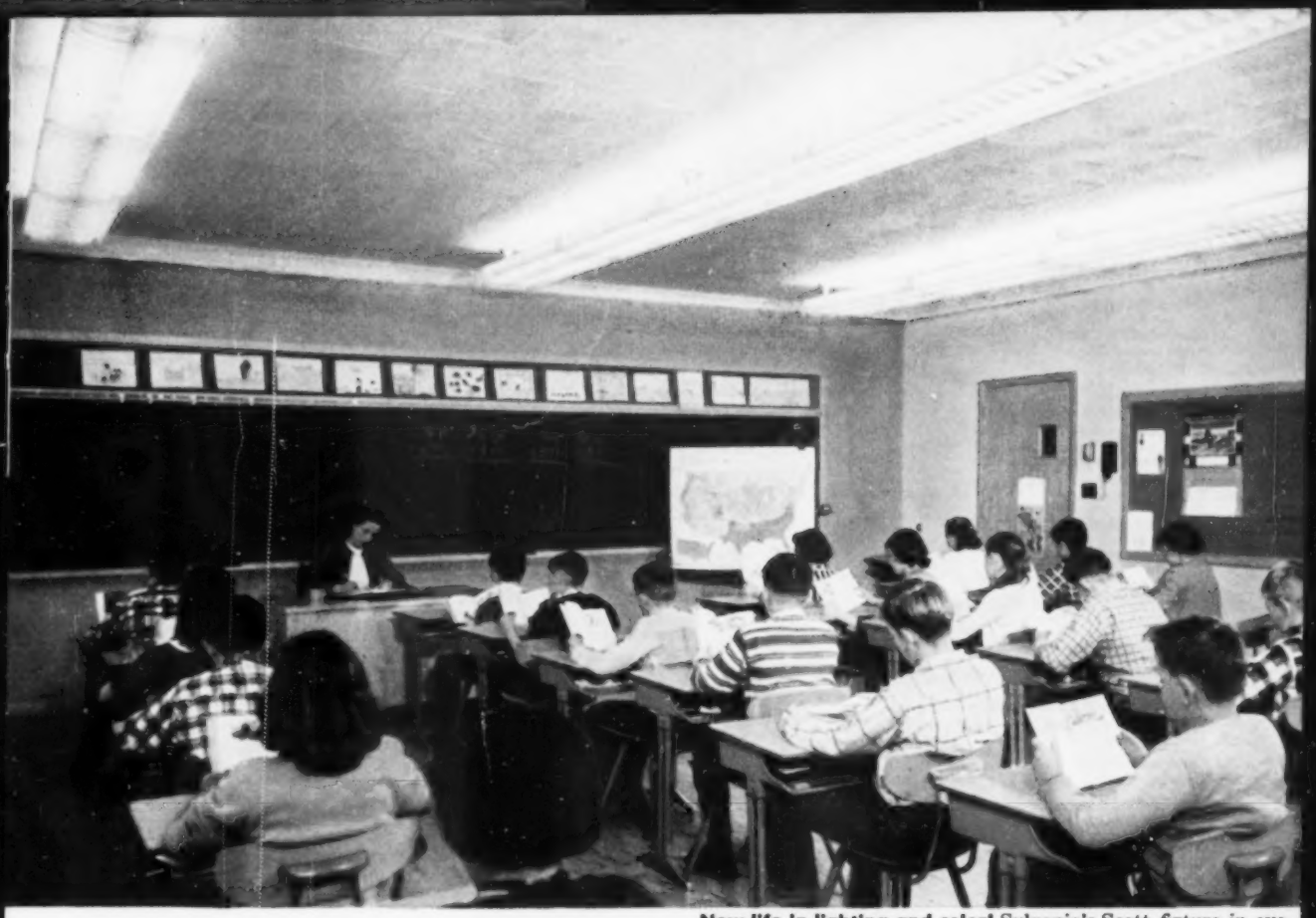
The Scott's eye-rest green plastic adds a new lighting element—*cool chromatic eye comfort*. It blends well with vari-colored pastel interiors . . . pinks, blues, yellows and tans. The whole effect gives students better seeing conditions in pleasant, work-inspiring surroundings.

The Scott provides extremely high illumination efficiency. With its translucent louver, it softens overhead contrasts, and shields young eyes from direct lamp glare.

Maintenance supervisor R. Palin likes the Scott's one-man maintenance features. Four-foot shields are lightweight . . . swung down easily for lamp changes . . . removed quickly for cleaning.

The *latest* and the *right* classroom lighting, with Sylvania's *Scott*, make big differences here . . . in seeing conditions, appearance, and lighting economy over the long and short haul. It can make the same big differences in *your* next remodeling job, new wing, or new building. Talk to your Sylvania Fixture Specialist for complete lighting information. And write today for our FREE information folder on lighting with the sensational Scott . . . for schools.

SYLVANIA ELECTRIC PRODUCTS INC.
Dept. A-30, Lighting Division—Fixtures
One 48th Street, Wheeling, W. Va.



New life in lighting and color! Sylvania's Scott fixture in eye-rest green shows off this new pastel tan classroom in its best light.

color-engineered classrooms come alive

In pastel pink rooms, the Scott's eye-rest green color complements color schemes of walls and furniture.

In pastel yellow rooms, the fixture's green tint pleasantly accents the full richness of room color.

In pastel blue rooms, the green Scott adds a new kind of chromatic coolness to room décor.

The Scott—close up. Fixture offers high efficiency, finest shielding, new light-green tinted shielding for classroom lighting.

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(Continued on page 29A)

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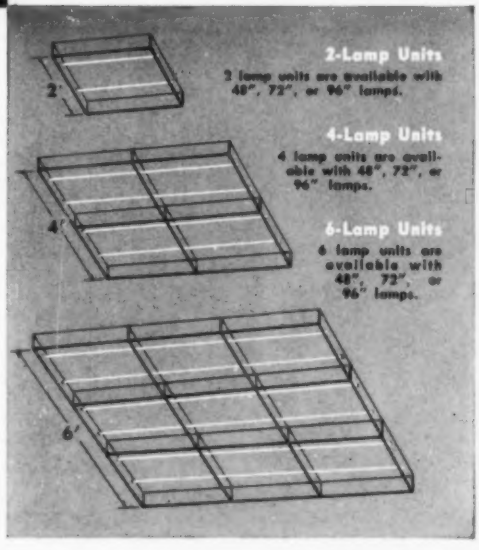
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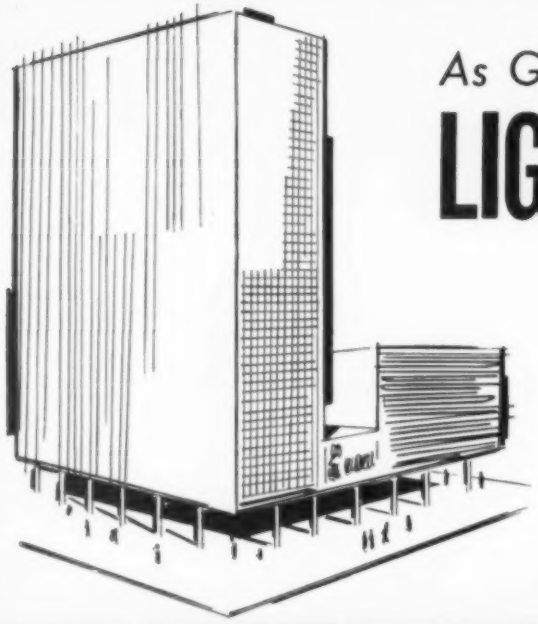

As General Electric sees it...

LIGHTING PROGRESS

The fluorescent lighting industry has made tremendous progress in recent years. Advances in architectural styling, backed by new fixture designs and better application techniques, have brought to millions better light for modern living.

But progress almost always awakens new problems. So it is with lighting. For modern fluorescent installations, with all their style and efficiency, necessitate increasingly rigid control of ballast operating temperatures. Here's why:

New architectural designs incorporate lower ceilings, and sound-absorbing ceiling materials. Lighting fixtures are flush-mounted or recessed. There is also a growing demand for

DEMANDS BALLAST PROGRESS

higher working foot-candles. This means more lamps per fixture and higher lamp currents. To reduce possible glare caused by higher light output, fixtures now utilize louvers or lenses, which contribute to the retention of heat. And, because space is limited, smaller cross-section ballasts are used. Thus, modern fixtures *generate more lamp and ballast heat, yet are less able to dissipate it*.

Because ballast life may be shortened if ballast temperatures are excessive, modern lighting design and application techniques place huge demands upon the ballast industry. If fluorescent lighting progress is to continue, better ballasts which will operate below standard industry heat specifications in modern applications must be developed. *Thus, lighting progress demands ballast progress.*

In working toward ballast progress, General Electric engineers have recognized that high ballast operating temperature is perhaps the largest problem to be overcome. The most important single step in solving this problem has been the development of a realistic new approach and new facilities for accurately measuring ballast operating temperatures. In a specially-constructed, temperature controlled laboratory, ballasts are actually installed in modern, totally enclosed fixtures, without the aid of heat dissipating devices (except for normal ballast base contact with the fixture channel). These fixtures are flush-mounted or recessed against typical acoustical ceilings. Thermal measurements are taken only after the ballast has reached a stable operating temperature. *Thus General Electric ballast heat measurements reflect actual, modern operating conditions.*

As a result of such research, General Electric's entire ballast line is continually undergoing major improvements designed to provide superior performance. The most recent example of G.E.'s research and development is the redesign of its 89G545 line of 40-watt, rapid-start ballasts to operate efficiently well below the industry standard of 90°C. in modern applications. Such ballast progress allows maximum latitude in fixture design and styling.

Specify General Electric ballasts! They are engineered to back up your efforts toward modern, functional lighting—*and lighting progress.* As we see it, General Electric ballast progress *is* answering the needs of lighting progress. General Electric Co., Section 401-52, Schenectady, N. Y.

New G-E testing laboratory simulates ballast operating conditions in modern fixtures, assuring realistic heat measurements.

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(Continued on page 30A)

(Continued from page 29A)

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58 North Second Ave.
Mt. Vernon, N. Y. — *Bert Greene*

Main Electric Co.
741 Milwaukee Ave.
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Major Equipment Co. Inc.
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R. A. Manning Co.
1810 North Ave.
Sheboygan, Wis. — *R. A. Manning*

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Fanwood, N. J. — *R. A. Schiller*

Marvin Manufacturing Co.
648 Santa Fe
Los Angeles, Calif. — *Howard Brinton*

Massachusetts Gas & Electric Light Supply Co.
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Boston, Mass. — *Jason Weiner's*

McNaughton-McKay Electric Co.
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Brooklyn 37, N. Y. — *Edward L. Gluck*

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Chicago 47, Ill. — *P. G. Schannon*

Meade Electric Co. Inc.
5401-15 W. Harrison St.
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Reading, Pa. — *T. O. McQuiston*

Metropolitan Electrical Supply Co.
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Detroit 21, Mich. — *Milton J. Doner*

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15th & Gentry Sts.
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Meriden, Conn. — *John J. Neidhart*

Miller Electric Co. of Florida
575 Dora St.
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Mine Safety Appliances Co.
201 N. Braddock Ave.
Pittsburgh 8, Pa. — *R. E. Havener*

Mississippi Glass Co.
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Lampton Bldg., Jackson, Miss. — *B. M. Davis*

Mississippi Power Co.
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Rimouski, Que. — *J. Henri Labrie*

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Chicago, Ill. — *M. L. Offenberg*

Moe Light Division
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Louisville 2, Ky. — *Frank Marriett*

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Girard, Pa. — *Finley J. Gordon*

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540 Empire State Bldg.
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49 Westminster St.
Providence 1, R. I. — *C. R. Broadhead*

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Luminall Paint Division
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Cleveland 15, Ohio — *M. W. Terkel*

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Washington, D. C. — *David Leventhal*

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New York 10, N. Y. — *Philip Young*

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Chicago 34, Ill. — *N. E. Passman*

Newark Electric Fixture Co.
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New Orleans, La. — *E. N. Avegno*

N. Y. State Electric & Gas Corp.
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Binghamton, N. Y. — *Earle C. Edwards*

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Syracuse 2, N. Y. — *F. T. McEvoy*

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P. O. Box 910
Halifax, N. S. — *W. D. Graham*

NuArt Lighting & Mfg. Co.
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Salt Lake City, Utah — *H. A. Schoepf*

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Akron 8, Ohio — *Franklyn Dickinson*

Ohio-Midland Light & Power Co.
Canal Winchester, Ohio — *J. E. Cathers*

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Omaha Public Power District
720 Electric Bldg.
Omaha 2, Nebr. — *E. E. Schwalm*

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Pacific Power & Light Co.
920 S. W. Sixth Ave.
Portland 4, Ore. — *F. M. Reis*

Paramount Industries Inc.
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Flint, Mich. — *B. R. Bailey*

Peerless Electric Ltd.
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Montreal 36, Que. — *L. A. Van Duzer*

Pennsylvania Electric Co.
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Johnstown, Pa. — *R. G. Baker*

Pennsylvania Power & Light Co.
901 Hamilton St.
Allentown, Pa. — *H. H. Brenan*

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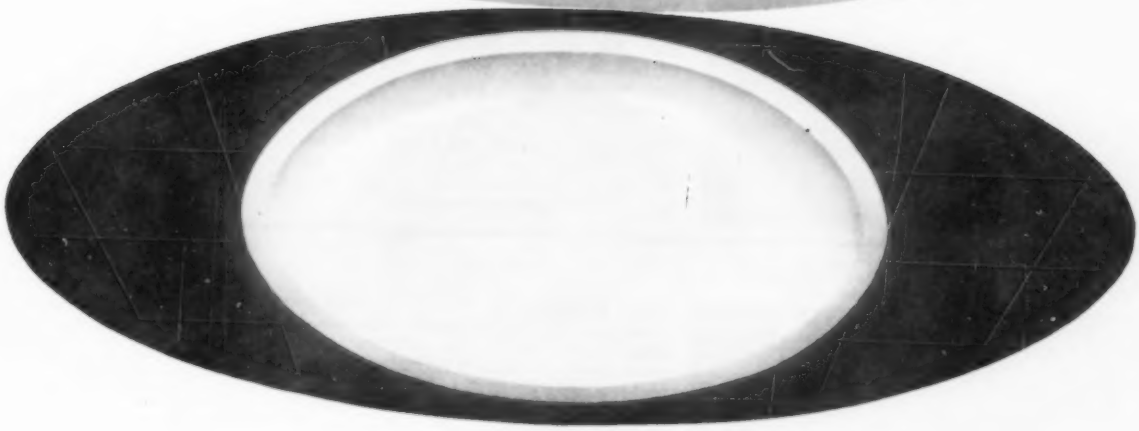
(Continued on page 33A)

Futuristic in styling

Futuristic in engineering

PATTERNS OF THE FUTURE



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these handsome "large area," recessed, 4-foot in diameter, circular Visionaires: the SP3840 series. Besides widening the architectural-designer's range of dramatic concepts in interior designs, the SP3840 is ideal either as a contrast fixture or the dominant shape in the ceiling theme. Matte-finish translucent white Plexiglas affords distinctive illumination: unusual low brightness, minimum glare and greater visual comfort. Diffusers are concave for added strength and structural stability. Fixture-body is square for easy installation. Loosening of only 4 screws permits fully framed diffuser to be lowered on concealed slotted hinges for relamping without removal. Bonderite treated against corrosion and finished in high reflectance, all white baked enamel. Also available 24" and 36" in diameter. Write for bulletin D-49.

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Revere Outdoor Lighting Report

For lighting engineers, lighting planners, and architects interested in outdoor lighting problems and trends.

Lighting an Auto Sales Location

The Problem: To attract motorists' attention to the large number and type of new cars, and to dramatically illuminate building exterior. Frontage is 380 feet.

The Answer: Revere incandescent floodlighting, highlighting true color of cars. Two No. 4213-P floodlights are mounted 24 feet above grade with 31 feet spacing except for driveways. Thirteen 5-light cluster assemblies No. 3245 are mounted 9 feet above grade to add "sparkle" to cars on display. Floodlights use 1000-watt PS-52 clear lamps. Cluster lights use Par 38 150-watt lamps. For easy maintenance, 13 Revere 199-E-24 hinged poles support floodlights.

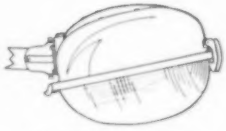
No. 4213-P Floodlights

No. 3245 Five-light cluster and splicebox

Lighting a City Street

The Problem: I.E.S. recommended *minimum* average footcandles not considered adequate for one of Chicago's heaviest travelled streets because of its high accident rate and low reflectance of newly paved blacktop surface. Design for uniform 3 footcandles average maintained illumination.

The Answer: Revere No. 2284 Endoval Type III street lighting luminaires with 400-watt E-H1 mercury lamps. Endovals with 10° tilt are mounted 29 feet above grade with 83 feet opposite spacing. Overhead wiring is used to take advantage of existing power after recent removal of street car line.



No. 2284 Type III Endoval

Lighting a Shopping Center Parking Lot

The Problem: To provide an attractively illuminated parking lot appealing to shoppers, and to enable those using the area to locate their automobiles easily and safely. Parking area is 240 feet by 106 feet.

The Answer: Three Revere No. 5440 Ultra-Lites mounted 34 feet above grade, and spaced on 70 foot centers, to provide an average illumination of 4 foot candles. Each Ultra-Lite uses four E-H1 400-watt mercury lamps positioned for widest coverage and highest illumination level. Ultra-Lites throw square light patterns which overlap to eliminate "dark spots" and build up light values in fringe areas.

No. 5440 Revere Ultra-Lite

No matter what the lighting problem — if it's outdoors, Revere has the equipment, or can engineer it, to provide your best lighting answer. Write for catalog covering Revere's complete line of matched outdoor lighting equipment.

Revere ELECTRIC MFG. CO.

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(Continued from page 30A)

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Edina, Minn. *Donald D. Olson*

Phoenix Glass Co.
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Pierce Electric Co.
367 W. Adams St.
Chicago 6, Ill. *John H. Pierce*

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Port Allegany, Pa. *Howard F. Kingsbury*

Pittsburgh Plate Glass Co.
Grant Bldg.
Pittsburgh 19, Pa. *R. G. Whittemore*

Pittsburgh Reflector Co.
403-411 Oliver Bldg.
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Portland, Ore. *T. W. Fitch*

Poindexter Electric Co.
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Hagerstown, Md. *C. D. Lyon*

Potomac Electric Power Co.
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6615 Milwaukee Ave.
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Prolon Plastic Division
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Robert Manufacturing Co. Inc.
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Chicago, Ill. *Harold Zwitt*

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Solux Corp.
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The Spero Electric Corp.
20500 St. Clair Ave.
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Chicago 16, Ill. *Jerome Gimbel*

(Continued on page 34A)

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4300 W. Chicago Ave.
Chicago 51, Ill. *P. M. Pavesich*

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83 Laurel St.
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Universal Lighting Products, Inc.
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Wheeling Electric Co.
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Chicago 41, Ill. *T. J. Wigdahl*

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Buffalo 7, N. Y. *Robert C. Graves*

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939 Southbridge St.
Worcester 3, Mass. *Donald S. Bennett*

Work-O-Lite Co.
522 Cortlandt St.
Belleville, N. J. *Jack Siegel*

Wright Light, Inc.
2924 Commerce St., P. O. Box 4155
Houston, Texas *Merrill C. Wright*

Zenith Electric Supply Ltd.
185 Bridgeland Ave.
Toronto 10, Ont. *B. R. Steen*

ABOUT PEOPLE

Southern California Edison Co. has announced several organizational changes. **Bruce Renwick,** formerly vice president and general counsel has been elected vice-president and senior counsel. He has been with the company for 15 years. Replacing Mr. Renwick as general counsel is **Rollin E. Woodbury,** former assistant general counsel. **T. M. McDaniel, Jr.** was elected a vice president of the company from the position of executive assistant. Before joining Edison in 1956, Mr. McDaniel was a partner in Arthur Andersen & Co., a New York accounting firm.

Henry Gluck has been named vice-president in charge of sales of the Sunbeam Lighting Co., Los Angeles, according to a recent announcement. Mr. Gluck, who joined the firm as sales manager last spring will be in charge of all sales and distribution activities of the organization, including the network of local area sales representatives.

John D. Hodnette, of Pittsburgh, vice-president and general manager and a member of the board of directors of Westinghouse Electric Corp., has been awarded the 1957 Edison Medal by the American Institute of Electrical Engineers. The award was made "for his significant contributions to the electrical industry through creative design and development of transformer apparatus which marked new advances in protection, performance and service. For his

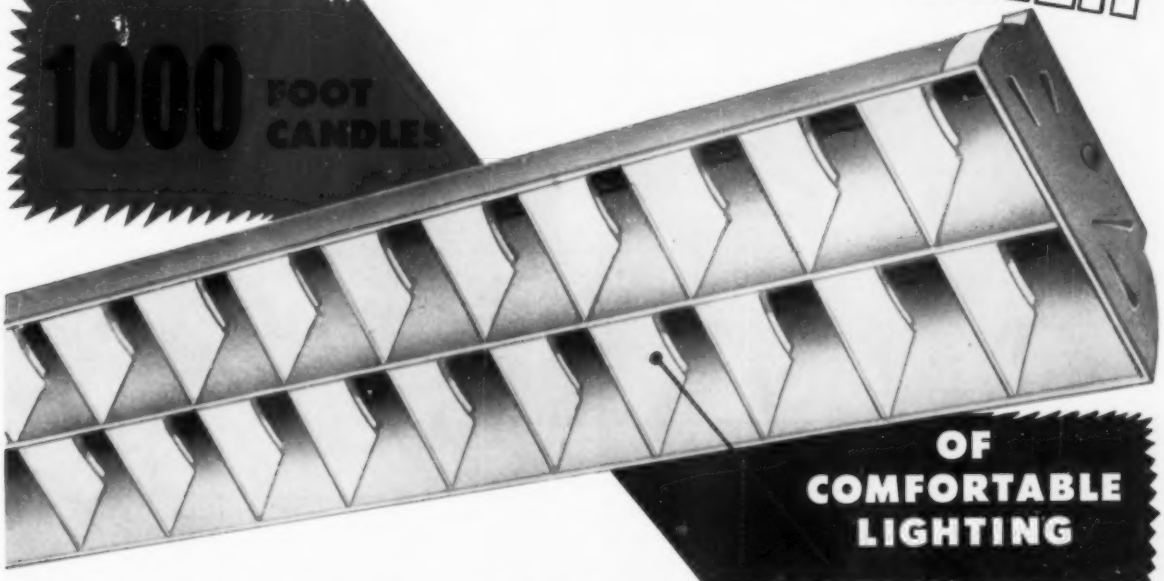
(Continued on page 45A)

LIGHT SCIENCE

BREAKING THE SIGHT BARRIER

WITH

1000 FOOT CANDLES



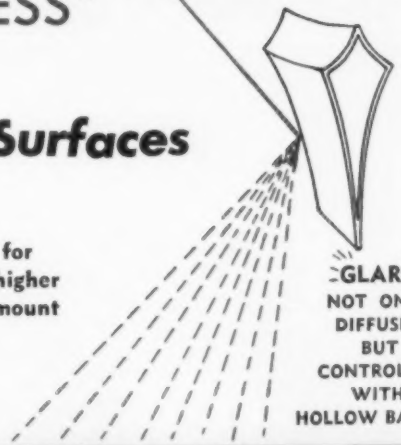
OF COMFORTABLE LIGHTING

"CONTROLLED BRIGHTNESS"

Through ALUMINUM and allPARABOLIC Reflecting Surfaces

Enables the new POWER GROOVE Lamps to provide The World's Highest Level of Comfortable Lighting.

For the complete story and how this lighting, developed for the Age of Space Satellites, can answer your problem of higher intensity illumination yet maintaining comfort, write Paramount Industries for information on Power Groove Fixtures.

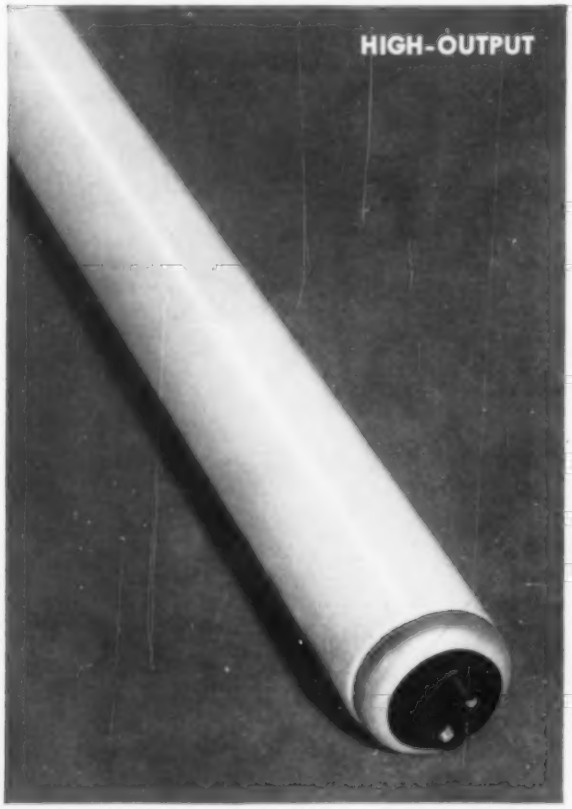


Paramount INDUSTRIES, INC.
FLINT, MICHIGAN

U. L. Approved and Tested with Power Groove, VHO and HO Lamps

Planning new buildings?

You'll get a lower cost of light by using one of these two G-E fluorescent lamps



G-E HIGH-OUTPUT LAMPS deliver 40% more light per foot than slimlines, at 5-10% lower cost of light. High-Output fluorescent lamps give you the same lighting level in cool white *deluxe* as *standard* cool white slimlines! General lighting for any sales area needs the richness of deluxe fluorescents that flatters merchandise and complexions.

G-E POWER-GROOVE LAMPS provide over 2½ times the light per foot as slimlines—at a 10-15% savings in cost of light. For ceiling and display lighting, exterior lighting and show windows, Power-Grooves can help create more sales appeal for stores and merchandise. You get the added light you want for selling, without a proportionate increase in maintenance costs.

If you'd like more information on these or any other G-E Lamps, fluorescent *or* incandescent, write: General Electric Co., Large Lamp Dept. IE-18, Nela Park, Cleveland 12, Ohio.

G-E SPOT AND FLOOD LAMPS SUPPLEMENT YOUR GENERAL LIGHTING

300-WATT PAR-56 SPOT LAMP

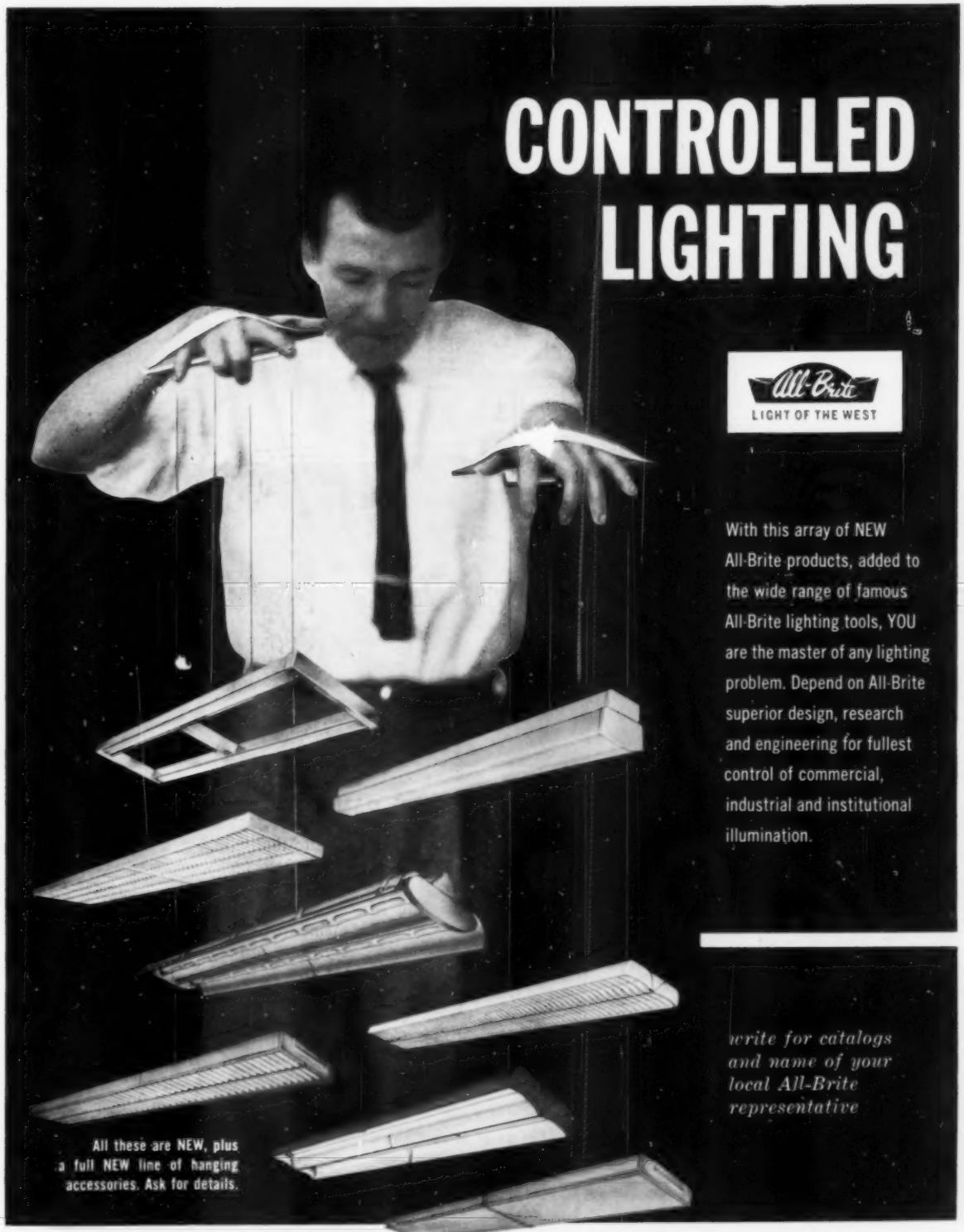
300-WATT PAR-56 FLOOD LAMP

Of course, fluorescent ceiling lighting is but one part of your over-all lighting system. You'll also want to use incandescent lamps to add sparkle and glitter to merchandise. You may want spotlighting in certain areas, floodlighting in others; you may want downlighting, perimeter canopy lighting, and lighting built into cases, gondolas and merchandisers. At left are two new lamps from G-E's complete line of spot and floodlamps that are designed to do these jobs best for you.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CONTROLLED LIGHTING



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LIGHT OF THE WEST

With this array of NEW All-Brite products, added to the wide range of famous All-Brite lighting tools, YOU are the master of any lighting problem. Depend on All-Brite superior design, research and engineering for fullest control of commercial, industrial and institutional illumination.

All these are NEW, plus a full NEW line of hanging accessories. Ask for details.

write for catalogs and name of your local All-Brite representative

FLUORESCENT FIXTURES OF CALIFORNIA

352 SHAW ROAD
SOUTH SAN FRANCISCO, CALIF.

PLANTS ALSO IN LOS ANGELES; PORTLAND, OREGON; AND VANCOUVER, B. C., CANADA

IT'S A SNAP!... to install PITTSBURGH'S NEW "SEE-WAY" LUMINAIRE

GENERAL CHARACTERISTICS

The SEE-WAY is an All-White 2-lamp direct-indirect luminaire for surface or pendant mounting. It's made of highest quality electrical components. All parts are die-formed of 20-gauge sheet steel; prefinished by the Parker Bonderite iron phosphate process for corrosion resistance. Comes in 4 and 8 foot sections.

PLASTIC SIDE PANELS "SNAP" INTO PLACE

Here is a brand new feature that will save many hours of installation time . . . and greatly simplify panel removal for cleaning or replacement.

Side panels are flexible diffusing ribbed polystyrene . . . easy to handle, ship, and maintain. Light in weight, they reduce the ceiling load appreciably. They also add to the appearance and overall efficiency of the unit.

The light from the See-Way is glare-free, comfortable, easy to work under. Perfect for classrooms, offices, or wherever visual comfort is necessary to maintain peak working efficiency over long periods.

See-Way's low cost makes it easy on the budget too!

For other advantages on the SEE-WAY you ought to know about,

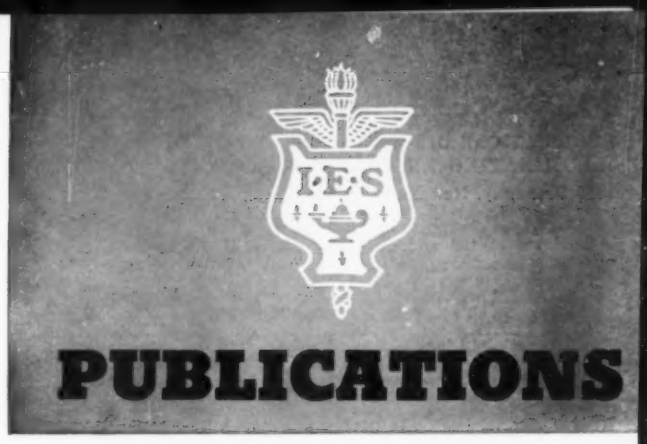
WRITE FOR BULLETIN M-11.

PITTSBURGH REFLECTOR COMPANY

411 OLIVER BUILDING, PITTSBURGH 22, PA.

Lighting Engineers in All Principal Cities

PITTSBURGH LIGHTING EQUIPMENT IS DISTRIBUTED BY BETTER ELECTRICAL WHOLESALERS EVERYWHERE



(Supersedes all lists prior to January 1958)

(1) I.E.S. LIGHTING HANDBOOK, Second Edition

LATEST! One volume, 987 pages. Published 1952. Complete revision of first edition includes basic information on all phases of lighting practice and technique, based upon recently developed standards. Contains 18 technical reference and application sections; complete appendices of information regularly used; 655 photos, drawings, lighting tables, charts; fully cross-indexed . . . over 4500 items. For use of lighting engineers and specialists, consultants, architects, designers . . . all who plan, install and manufacture lighting systems and equipment.

$8.00 per copy; $6.40 in lots of ten or more. Add 50c for shipment abroad. *I.E.S. Members are entitled to one copy of the Handbook at $5.50 unless previously ordered.*

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These booklets are the complete, standard recommendations for lighting the prescribed areas, and are among the most comprehensive and important of all Society publications. As indicated, some of these recommendations are the work of committees of the American Standards Association, with collaboration by appropriate committees of the I.E.S. All have the approval of the Council of the Illuminating Engineering Society, and are the latest official I.E.S. recommendations.

In general, the information contained in these Recommended Lighting Practices covers completely the area shown in the title. Included in the data are suggested types of lighting systems and luminaires; levels for general lighting and for specific areas; analyses of seeing tasks; and other information essential to lighting the area and of value to lighting engineers and specialists, architects, construction people and others. Each practice is fully illustrated with charts and photographs.

RP-1 OFFICE LIGHTING
I.E.S. Recommended Practice 32 pp. 50c

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Lighting recommendations based upon studies (research, surveys of current practice, and experimental installations) of I.E.S. Committees and Subcommittees covering all phases of lighting. Completely illustrated, these reports contain detailed information on many lighting problems peculiar to the industry or operation involved as well as providing general data as to lighting systems and luminaires; recommended quantity and quality of illumination; and analyses of specific seeing tasks.

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Printed on heavy gloss paper, punched for standard ring binder, data sheets are an excellent "idea" file for lighting people, consulting engineers and architects; ideal for promotional distribution by manufacturers and light and power companies.

I.E.S. Lighting Data Sheets are delivered throughout each year in groups of eight; three mailings for the entire 24-sheet series. First eight of each series are mailed for delivery in June; second eight in October; final eight in February of following year. Subscription, 24 sheets per set, $1.25; 10 or more sets, $1.00 each. Prices on minimum quantities of 100 individual sheets upon request to this office.

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Lithograph outline for a one-semester introductory lighting course suitable for college students or adults. Quantities of 10 or more, 75c per copy.

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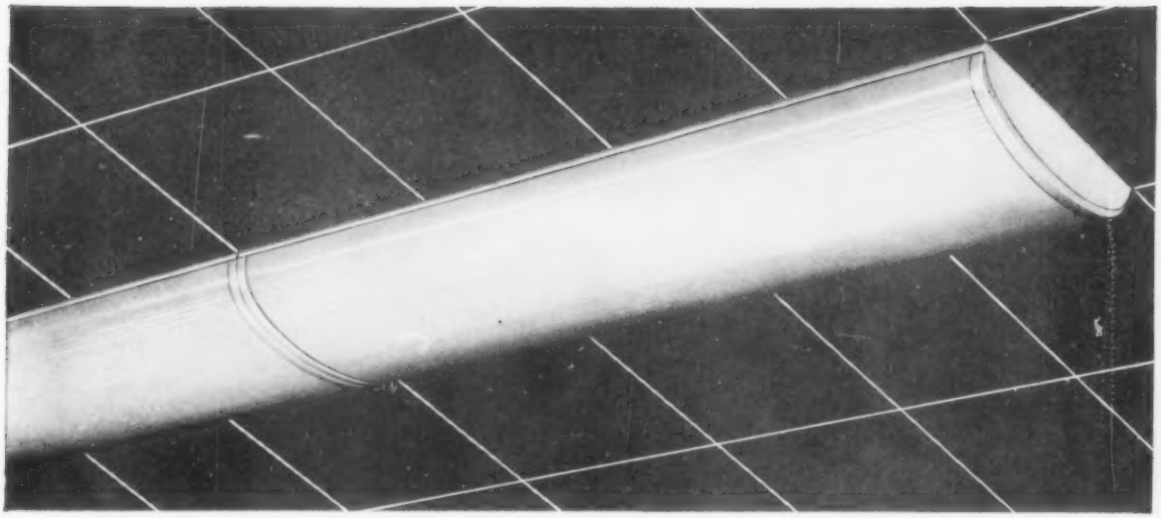
Surface-Mounted Cost



GARCY Ultra-Lux . . . shallow, plastic enclosed fixture . . . ideal for low ceiling lighting

Minimum depth consistent with good light distribution and brightness control

With curved shield, unit is only 3¼" at its deepest point . . . yet surface brightness is virtually uniform at all viewing angles and well within acceptable limits for glare-free comfort.

Improved light-stable extruded plastic guaranteed not to warp or discolor

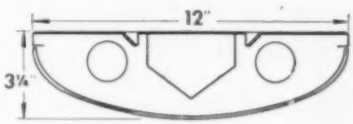
Shield is of Koppers improved EVENGLO*, a premium-grade polystyrene with built-in resistance to discoloration caused by ultra-violet radiation of fluorescent lamps.

Easy to install . . . only two basic parts

Completely assembled chassis with integral end plates is lightweight, sturdy, easy to handle. Separately cartoned one-piece shield hooks on after installation.

Easily cleaned . . . no need to remove shield from fixture

Curved shield is invisibly framed and hinged . . . lets down at a touch, wipes clean in seconds.



*EVENGLO is a registered trade mark of Koppers Company, Inc.

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Preferred for Performance
COMPLETE COMMERCIAL LIGHTING

Garcy offers a complete line of lighting fixtures for commercial, institutional and display lighting.

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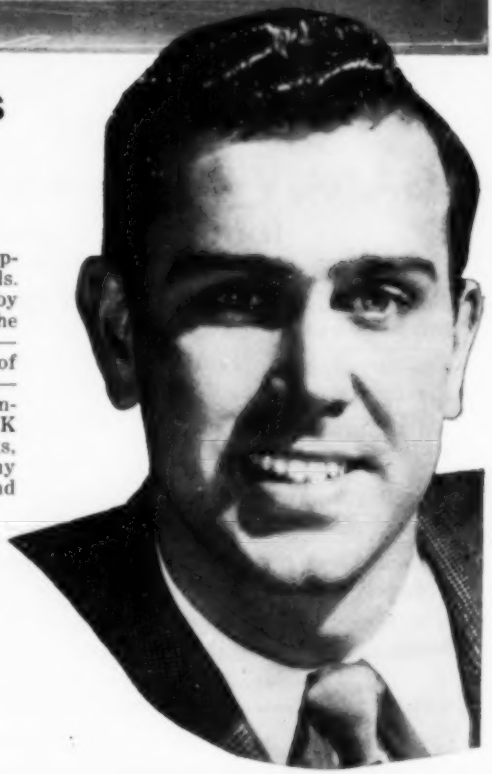
P&K

PACKAGED LIGHTING UNITS

make the job easier!

To complement the modern architectural style, the Westlake Shopping Center, Westlake, California, chose P & K lighting standards. Why not? They obtained the desired quality of lighting and, by having the entire unit supplied by one reliable source, they made the job so much easier. With so many P & K groupings to choose from—davit or straight standards or more artful shapes—and a choice of three light sources, incandescent, fluorescent, or mercury vapor—Westlake, in effect, customized their installation with standard components. Needless to say, they enjoy all the advantages of P & K aluminum lighting standards, for, in addition to their good looks, they offer easy installation, no maintenance. Before you specify any lighting standards check the P & K catalog first. For your copy send for Catalog L-2.



WESTLAKE PREFERRED THE P & K 32-FOOT DAVIT STYLE STANDARD

whose sweeping, tapered lines are in perfect harmony with the surroundings. The luminaire itself is the P & K LUXaire—a weather tight fluorescent fixture that allows for convenient lateral adjustment and easy relamping. The four flourescent tubes of this six-foot model provide 21,000 lumens. Other LUXaire's from 2 to 8 foot provide from 6,000 to 40,000 lumens.

P&K

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TWA TICKET OFFICE, ROCKEFELLER CENTER

Interiors with sales appeal have wall-to-wall Honeylite.

There's a big reason why two major transportation companies in one month have chosen Honeylite for their important Manhattan ticket sales offices. The reason is customers like a Honeylite atmosphere and buy! (Employees like Honeylite, too, and make fewer errors because their eyes are fresh and rested all day long.)

Why does the public like a Honeylite ceiling so much? Well, first of all, Honeylite is always spotlessly clean. Dust and dirt just fall through—can't stick to Honeylite because it's non-static. Honeylite rooms have a cool and airy feeling. Overhead air-conditioning systems are actually made more efficient by the thousands of little hexagonal "wind tunnels" in each square foot of Honeylite...(yet these unsightly utility systems are obscured). And, of course, Honeylite casts a completely glare-free flattering light—with nearly perfect efficiency.

See our Catalog in Sweet's file 31c/He

HONEYLITE®
LIGHT-DIFFUSING ALUMINUM HONEYCOMB
A DEVELOPMENT OF **HEXCEL PRODUCTS INC.**
951-61ST STREET, OAKLAND 8, CALIFORNIA

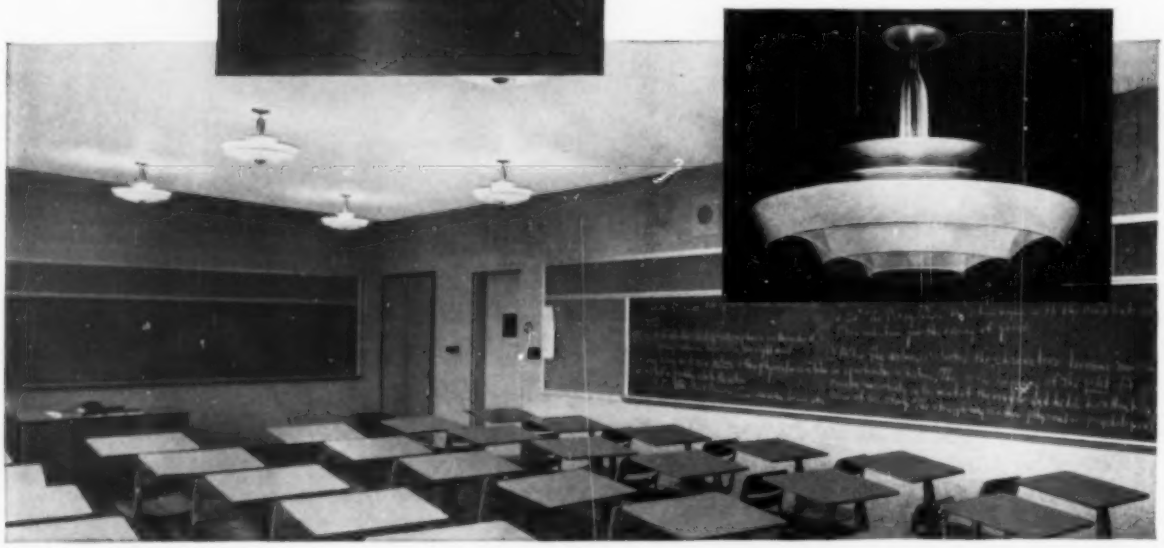
Modern Lighting
by
PERFECLITE

makes learning easier on young eyes . . . increases teaching efficiency

For schools, where visual comfort is such a vital factor in scholastic achievement and physical well being, more and more architects and engineers specify Perfeclite. Case in point—the recently renovated and enlarged Peters Township, Pa. Junior-Senior High School, where one million dollars was spent in repairs and new building. Perfeclite fixtures light the way in classrooms and corridors—help create an ideal environment for students and teachers alike.

In schools, offices, factories—in fact, wherever you have a commercial or institutional lighting problem—there's a low cost, easy-to-install Perfeclite fixture ideally suited to your requirements.

Write today for further information.



INSTALLATION: Peters Township, Pa. Junior-Senior High School.
AREA SHOWN: Typical classroom and corridor.
ARCHITECTS: Beall & Parkins, Washington, Pa.
ELECTRICAL CONTRACTOR: Edward Regula, Belle Vernon, Pa.
FIXTURES: Perfeclite F-387-AT recessed asymmetric drop prismatic lens 200 watt corridor fixtures. Perfeclite P-303 plastic three ring shadowless, non-glare translucent 500 watt ceiling fixtures.
CEILING HEIGHT: 8'6" in corridor —11'10" in classroom.
FIXTURE SPACING: 9'6" in classroom—12'0" in corridor.
INTENSITY: 46 ft.-candles average throughout classroom at desk level. 20 ft.-candles average throughout corridor at locker level.

THE PERFECLITE COMPANY
1457 EAST 40th STREET • CLEVELAND 3, OHIO

Fixtures are Underwriters Laboratories, Inc. approved

(*Continued from page* 34A)

vision, judgment and management skill which fostered and achieved the practical application of his ideas with resulting advancements in the electrical industry." The Medal will be presented to Mr. Hodnette at the opening general session, Monday, Feb. 3, of the Winter General Meeting of the AIEE at the Hotel Statler, New York City, Feb. 3-7.

Peerless Electric Co., San Francisco, has appointed **John C. Epperson,** formerly president of J. C. Epperson Co., as national sales manager. Mr. Epperson is vice-chairman of the Golden Gate Section of IES. **Charles Krinard** has been promoted to sales and service coordinator of Peerless.

Richard Hesse has been made sales engineer in charge of Sola Electric Co.'s recently opened sales office in New Haven. Mr. Hesse was formerly sales manager of Condenser Products Division of the New Haven Clock Co.

The retirement of **C. E. Davies** after 23 years as Secretary of the American Society of Mechanical Engineers has been announced by the Council of the Society. Mr. Davies will continue to serve the profession as coordinator for the United Engineering Center. **O. B. Schier, II** has been elected as the new Secretary of the Society.

Arthur A. Weeber has been appointed tool engineer at Curtis Lighting, Inc., Chicago. Prior to joining Curtis, Mr. Weeber was process engineering supervisor at American Bosch Arma Corp.

The acquisition of the Fullerton Manufacturing Corp., Norwalk, Conn., as a new member of the group of associated companies making up the Franklin Research Corp. was announced by **Henry E. Kingman,** president of Franklin, in Boston. **Lawson Fullerton,** formerly president of Fullerton Manufacturing and **Warren A. Beh,** vice-president, were elected vice-presidents and directors of Franklin.

Granville Berry has been elected vice-president of the Association of Public Lighting Engineers in England.

The Engineering Institute of Canada has announced the establishment of a medal in honor of **Robert W. Angus,** Hon. M.E.I.C., Emeritus Professor of Mechanical Engineering at the University of Toronto. The medal will be

(*Continued on page* 46A)

ALWAYS GOOD LIGHT

thanks to

CHAMPION LIGHTMANSHIP

Strict Quality Control—

One example of how Champion applies Lightmanship to make sure you get all the light you pay for. Photometric testing, as shown at the left, helps in maintaining the light output of Champion Lamps at the highest possible level.

MILLIONS OF LAMPS A YEAR . . .
ONE PLANT standard of quality control

CHAMPION Lamps

Incandescent Fluorescent

Your best buy in lamps

CHAMPION LAMP WORKS

Lynn, Massachusetts

A division of Consolidated Electric Lamp Co.

new

lighting design by mc Philben

mcPhilben's new 37-60 line designed by E. Allan Rothman provides the most efficient lighting of fitting rooms, mirrors, stair landings, telephone bookstands . . . wherever localized illumination is desirable.

Available in both fluorescent and incandescent models offering these exclusive features: continuously hinged doors for easy relamping . . . all metal construction . . . baked on grey enamel finish . . . removable reflectors for easy access to electrical components.

37-60 Two 60 watt lamps
37-65 Two 15 watt T-8 fluorescent lamps

Contact your mcPhilben representative for full details. See our insert in Sweet's file 32a or write for data sheet C/27 mc

mc Philben
LIGHTING COMPANY
1328 WILLOUGHBY AVENUE, BROOKLYN 37, NEW YORK

(*Continued from page 45A*)

awarded each year for the best paper written on a mechanical engineering subject, by an engineer resident in Canada.

H. R. Weibel has been appointed manager of field sales for the Pyle-National Co., Chicago. Mr. Weibel, who joined Pyle-National in 1955 as district manager in St. Louis, was formerly associated with the General Electric Co., Lamp Division.

Sunbeam Lighting Co. has announced the signing of **Fred J. Vorlander** of Boston as district sales representative for Maine, New Hampshire, Vermont and Massachusetts. **Louis J. Coleman** of Charlotte, N. C. will represent Sunbeam in North and South Carolina.

Walter C. Granville, Chicago color consultant has been elected president of the Inter-Society Color Council at the December meeting. Other officers elected include **G. F. Erikson,** vice-president, **Ralph M. Evans,** secretary and **Norman Macbeth,** treasurer.

C. E. Weitz, Supervisor of the Technical Publicity unit at the General Electric Co., Nela Park offices, retired last July 31, after 38 years with the company. Mr. Weitz has served the I.E.S. in many capacities, both on its Technical and General Committees and as Chairman of the Cleveland Section. In 1955 he was made a Fellow of the Society.

By unanimous action of Council, at its December 12 meeting, **Earl A. Anderson** (Michigan Section), **Frank G. Horton** (Michigan Section) and **James M. Ketch** (Cleveland Section) were elected Members Emeritus of the Society.

Deaths

W. A. Chauvin, Albuquerque, N. M.
G. P. **Fuerst,** Cleveland, Ohio.
Clayton T. Gibbs, Los Angeles, Calif.
C. L. Goodman, New Castle, Pa.
F. S. Gregory, Alice, Texas.
John D. Haverkamp, New Orleans, La.
Harold W. Howard, Akron, Ohio.
Heins Kaiser, Neheim-Huesten, Germany.
J. A. Kertson, Minneapolis, Minn.
J. J. Miner, Detroit, Mich.
Lynn H. Morris, Salem, W. Va.
James C. Niemeyer, St. Paul, Minn.
George W. Patterson, Toronto, Ont.
J. L. Phillips, Birmingham, Ala.
R. M. Potts, Havertown, Pa.
A. E. Smiley, Kansas City, Mo.
T. R. Warren, Kansas City, Mo.

NEW MEMBERS

At the meeting of the I.E.S. Council on December 12, the following were elected to membership. Names marked *

(*Continued on page 47A*)

1958 Regional Conferences, I.E.S.

Region	Place	Date
Northeastern	Statler Hotel Hartford, Conn.	April 10-11
East Central	John Marshall Hotel Richmond, Va.	April 14-15
South Central and Southeastern	Lafayette Hotel Little Rock, Arkansas	April 24-25
Southwestern	Washington Youree Shreveport, La.	April 28-29
Midwestern	Hotel President Kansas City, Mo.	May 1-2
Inter-Mountain	Whitman Hotel Pueblo, Colo.	May 8-9
South Pacific Coast	El Cortez Hotel San Diego, Calif.	May 12-13
Pacific Northwest	Multnomah Hotel Portland, Oregon	May 22-24
Great Lakes	Sheraton Hotel Rochester, N. Y.	June 23-24

are transfers from Associate Member Grade. Names marked ** are transfers from Student Member Grade.

ALAMO SECTION

Member:

*Meehleib, W. E., Central Power & Light Co., Corpus Christi, Texas.

Associate Member:

Travis, Lon W., Beretta, Greenslade & Associates, Inc., San Antonio, Texas.

ARIZONA SECTION

Associate Members:

Cook, Neldon R., Arizona Public Service Co., Glendale, Ariz.
Hileman, Dick D., General Electric Supply Co., Phoenix, Ariz.
Lunt, Guy W., Arizona Public Service Co., Phoenix, Ariz.

ARKANSAS CHAPTER

Associate Member:

Young, Charles B., C. B. Young Sales Co., Little Rock, Ark.

ARK-LA-TEX CHAPTER

Associate Member:

Long, Michael G., Westinghouse Lamp Division, Shreveport, La.

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Associate Member:

Lightfoot, F. G., F. G. Lightfoot Co., Vancouver, B. C.

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Associate Members:

Colt, Alfred C., Westinghouse Electric Supply Co., Washington, D. C.
Harris, Mark, Cotton & Harris, Washington, D. C.
Mourning, Caroline B., Potomac Electric Power Co., Washington, D. C.

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Members:

Feinberg, Albert E., Advance Transformer Co., Chicago, Ill.
Wyscomirski, Stanley W., Vern E. Alden Co., Chicago, Ill.

Associate Members:

Chesney, Glen A., General Electric Co., Rockford, Ill.
Schulz, Charles L., Englewood Electrical Supply Co., Chicago, Ill.

CHINOOK CHAPTER

Member:

Lefebvre, Yvon H., Brown & Root, Ltd., Calgary, Alberta.

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Associate Members:

Needham, James E., Cleveland Elec. Illuminating Co., Cleveland, Ohio.
Page, George H., Thompson Electric Co., Cleveland, Ohio.
**Paugh, Ronald L., General Electric Co., Cleveland, Ohio.

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Associate Members:

Bemis, Paul D., Jr., Paul D. Bemis, Hartford, Conn.
Donnelly, Richard L., Graybar Electric Co., W. Hartford, Conn.
Dowling, William J., Graybar Electric Co., Hartford, Conn.

EDMONTON CHAPTER

Associate Member:

(*Continued on page* 48A)

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(*Continued from page 47A*)

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Brown, E. H., Jr., Southern College of Optometry, Memphis, Tenn.
Friedland, B. M., Southern College of Optometry, Memphis, Tenn.
Hedman, J. B., Southern College of Optometry, Memphis, Tenn.
Martin, F. D., Southern College of Optometry, Memphis, Tenn.
Schobel, W. A., Southern College of Optometry, Memphis, Tenn.
Schoenfeld, E. H., Southern College of Optometry, Memphis, Tenn.
Thomas, P. E., Southern College of Optometry, Memphis, Tenn.

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(*Continued on page 49A*)

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Brazell, James R., University of Miami, Miami, Fla.

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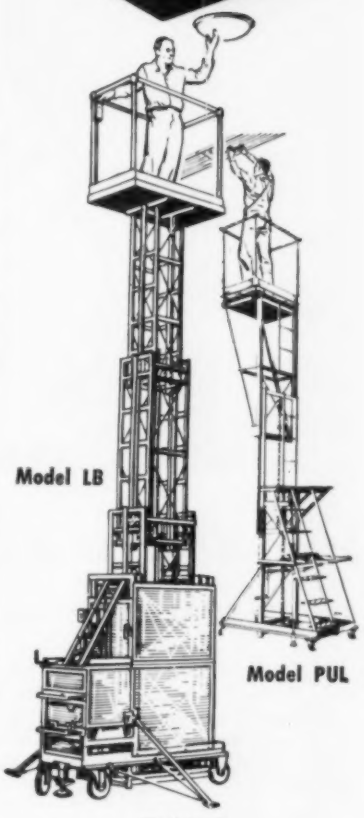

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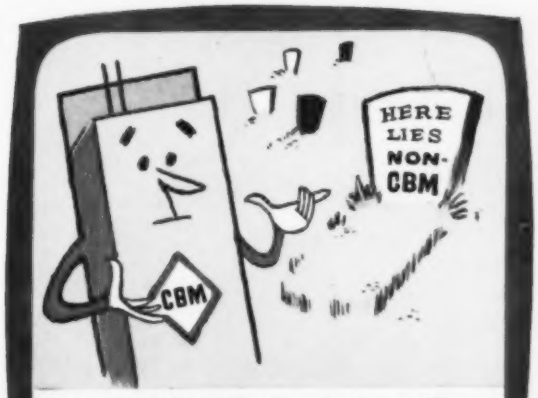

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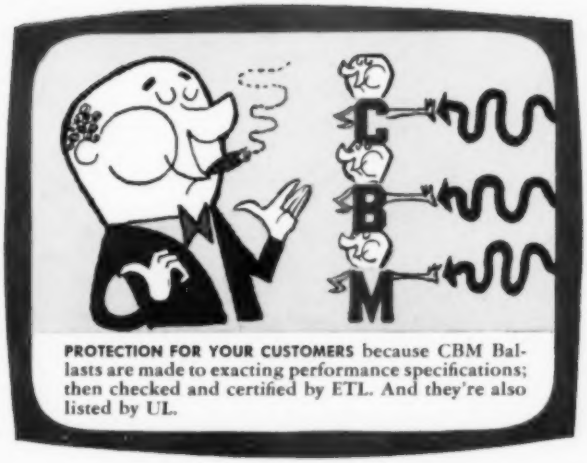

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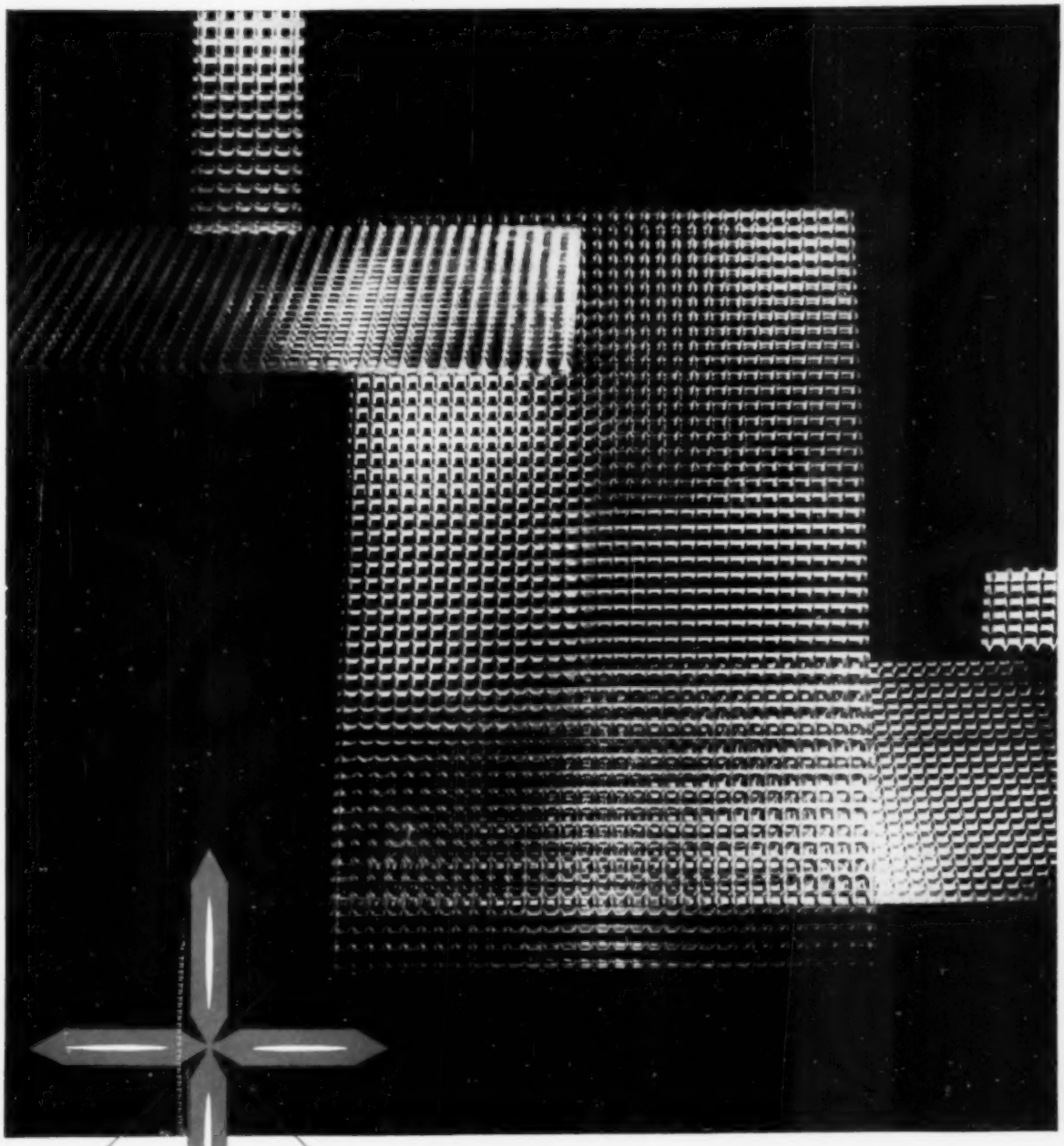

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